POSSIBLE FORMATION MECHANISMS OF CLASTIC POLYGONAL NETWORKS AROUND LYOT CRATER, MARS FROM MORPHOMETRIC ANALYSIS. L. M. Brooker[1], M. R. Balme[1], S. J. Conway[2], A. Hagermann[1], A. M. Barrett[1], G. S. Collins[3] and R. J. Soare[4]. [1]Department of Physical Sciences, Open University, Walton Hall, Milton Keynes, UK. (laura.brooker@open.ac.uk), [2]LPG Nantes – UMR CNRS 6112, Université de Nantes, France, [3]Department of Earth Science and Engineering, Imperial College, London, UK, [4]Department of Geography, Dawson College, Montreal, Canada.

Introduction: Polygonal networks of patterned ground commonly form in cold-climate environments as a result of the thermal contraction of ice-cemented soils (i.e. formed by fractures), or the freezing and thawing of ground ice (i.e. formed by ground deformation or 'sorted' patterns of clasts; Fig. 1) [1, 2]. Polygonal clastic features located around Lyot crater, Mars (50ºN, 30ºE) are enigmatic in that they are unusually large (130m mean diameter) when compared to terrestrial examples, and their margins are demarcated by very large clasts (up to 15m diameter). These polygons are located on the eastern side of the Lyot crater at a constant radial distance from the crater, and within the outer ejecta blanket, this indicates a possible genetic link with the ejecta. Morphological analysis of polygonal networks can provide information about past and present environmental conditions [3]. Using high-resolution remote-sensing data, we analysed these features and extracted morphological information to inform hypothesis-testing concerning possible formation mechanisms [4].

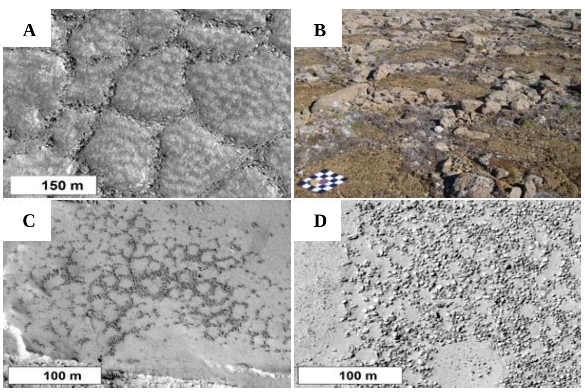

Figure 1: A) HiRISE image of part of a clastic polygonal network to the NE of Lyot crater. B) Morphologically similar terrestrial polygonal features on Tindastóll Plateau, N. Iceland. C) HiRISE image of possible sorted patterned ground in Elysium Planitia, Mars [5]. D) HiRISE image of possible sorted patterned ground in the Argyre region, Mars [6].

Study Area: Lyot crater is a ~215 km diameter, late-Hesperian-aged impact crater located north of Deuteronilus Mensae and the dichotomy boundary [7-9]. Lyot crater has a central peak and inner peak ring. It also has a continuous inner ejecta blanket with marginal scarp extending to ~1 crater radii, and a more hummocky outer ejecta extending to ~2.5 crater radii (Fig. 2). Large braided channels extend >300 km beyond the outer ejecta margins to the north, west and east of Lyot, which could be the result of groundwater release during the impact event [8]. There are numerous small fluvial channels present within the crater interior and inner ejecta blanket attributed to more recent fluvial activity [7, 10-11]. Thus the Lyot crater might record evidence of the action of both recent water sourced from the atmosphere and ancient water sourced from underground.

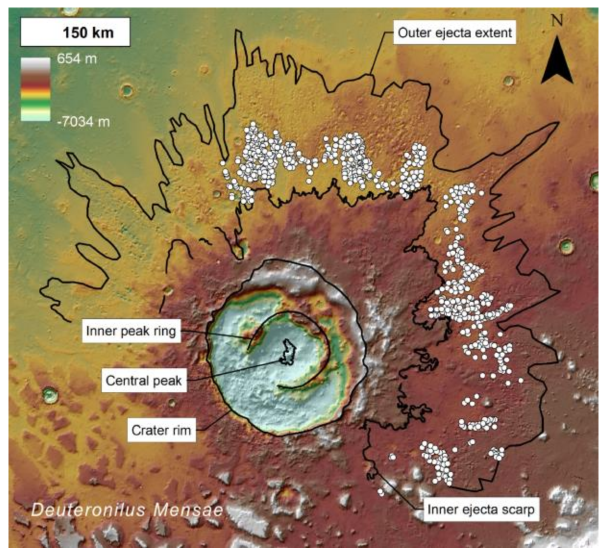

Figure 2: The Lyot crater study area displayed using colourised MOLA topographic data overlain on a MOLA hillshade. The crater peak, inner peak ring, crater rim, inner ejecta scarp and outer ejecta extent are indicated by black lines. Regions of clastic polygonal features are marked as white circles.

Data and Method: Six areas with HiRISE image coverage (HiRISE 'strips') that cover clastic polygonal networks to the north and northeast of the Lyot crater were identified. Digital Elevation Models (DEMs) were produced using HiRISE and CTX stereo pairs for analysis of aspect and slope. The polygons were digitized and analysed based on the method of [3] using ArcMap 10.1 software. Only polygons for which the margins could be determined as clastic were mapped. Mapping was done by digitizing polygon margins along their centre-lines with the start and end points corresponding to the intersection of other polygon sides or the lack of further clasts. Once all the polygons on each 'strip' were digitized, morphometric parameters, shown in Table 1, were calculated and extracted (Fig. 3).

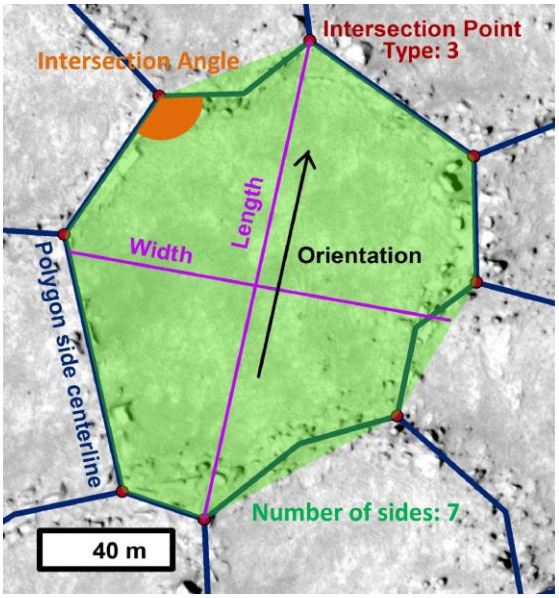

Figure 3: HiRISE image of a digitized clastic polygon with the scheme of the key extracted values displayed. The green shaded area indicates the minimum bounding area of the polygon. The polygon area is taken as the area within the blue digitized lines, and the perimeter is the total length of these blue lines.

Observations: Clastic polygonal features are recognizable even in CTX data as comparatively rough-textured, patterned areas on higher topography, surrounded by dark shadows cast by the clasts. Depressed areas are marked by a lack of polygonal features. No large boulder fields have been observed near to the studied polygons. The clastic polygons are irregular in size and form, although they are generally hexagonal to pentagonal in form. Polygon margins are composed of clasts which vary in form from small, approximately circular boulders, just at the image resolution, to large square and ridge-like clasts of 5m diameter or greater. Topographically high clastic margins give the polygons a low-centred appearance. No fractures or troughs have been observed near to or around the polygon margins.

Discussion and Conclusion: On Earth, there is a clear relationship between circularity and average slope, aspect and orientation, and between polygon size and clast size of sorted patterned ground [12]. There is no evidence for any of these relationships within the study region, this argues against the clastic polygons having a periglacial, freeze-thaw origin.

Table 1: Summary of morphometric parameters calculated and extracted from 3588 polygons.

Parameter	*Mean*	*Max.*	*Min.*	*Stan. Dev.*
Length (m)	179	676	19	78.053
Width (m)	117	450	11	10.799
Size (m)	130	435	16	56.179
Circularity	0.712	0.966	0.226	0.114
Intersection Angle (°)	116	268	19	34.397
Underlying Slope (°)	2	12	0	1.413
Clast Length (m)	5	15	1	2.196
Clast Width (m)	3	10	1	1.571
Clast Size (m)	5	12	1	1.993

Comparison of these data with other polygon datasets indicates that the polygons are more comparable in size and circularity to some thermal contraction crack polygons. However, if the polygonal clastic networks around the Lyot crater formed from thermal contraction networks, the formation mechanism needs explaining: clastic material at the boundaries is unlikely to simply accumulate by gravitational slumping of pre-existing clasts as there is no link to a surficial layer of clastic material. Other mechanisms also do not account for the clastic margins. We suggest that the clastic polygons result from the infill of thermal contraction cracks with wind-blown sediment that later becomes cemented or indurated, before erosion and weathering exposes and fractures the clasts into the pattern of blocks observed. This mechanism explains many of the observations made, but the large size of the polygons and mechanism of cementation is still difficult to explain and has not been observed elsewhere on Mars or Earth. The formation mechanism or environment of formation is thus unique to the Lyot area and further investigation is needed to fully understand how these features have formed.

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