Small scale polygonal patterns along the southern water ice margin on Mars

A. Johnsson (1), E. Delbratt (1), J. F. Mustard (2), R. E. Milliken (3), D. Reiss (4), H. Hiesinger (4), M. Olvmo (1)

(1) Department of Earth Sciences, University of Gothenburg, Guldhedsgatan 5 A, 413 20 Göteborg, Sweden (andreasj@gvc.gu.se / Fax: +46-31-7861986), (2) Brown University, Providence, RI, USA (3) NASA/JPL, Pasadena, CA, USA (4) Institut für Planetologie, Westfälische Wilhelms-Universität, Münster, Germany.

Abstract

From the high resolution images acquired by Mars Orbiter Camera an array of small scale polygonal patterns have been detected which range in size and shape. They occur in a continuous meters-thick deposit [1] interpreted to be ice rich which is observed at latitudes above 60° at both hemispheres, but which has undergone degradation at lower latitudes and is absent in the equatorial regions (within ±30°) [2]. Also, the Mars Odyssey’s Neutron spectrometer measurements of hydrogen emissions shows the presence of high water-ice abundance (>60% by volume) in the surface soils in the northern and southern latitudes above 60° [3]. The polygons interpreted to be forming in ice-rich terrain are thus strongly supported by indirect measurements of water-ice for those observed at latitudes higher than 60° S and for those at lower latitudes the morphology indicate a past when ice was stable to lower latitudes.

We have performed a comprehensive investigation of polygonal patterns along the latitudes of 30º S – 80º S on the southern hemisphere of Mars to highlight the change in morphology with latitude due to the presence or absence to subsurface water ice. The hypothesis is that the surface morphology would reflect the proposed subsurface ice content, similar to periglacial landscapes on Earth, which is both theorised [4] and measured indirectly by Mars Odyssey’s Neutron spectrometer. The idea is also to differentiate the genesis of polygons and link them to different processes and time of formation. As an addition we include dissected terrain data which reflect the absence of near surface ice due to sublimation. These previously unpublished results are the outcome of a master thesis project [5].

Data and methods

The identification of polygons has been made from the study of approximately 5000 high resolution MOC images that we obtained prior to January 2002. Only images showing clearly distinguishable polygons were used in this investigation. The features were identified by the presence of networks of polygons or circles to semi circles with dark or bright rims to the contrasting surface. The documented polygons were classed as orthogonal, random orthogonal and non-orthogonal (fig. 1) [6]. We also used three size classes of less then 50 m, 50-200 m and 200-300 m.

Fig. 1 a-d. a) Random orthogonal polygons, note a change in network density due to different soil condition. b-c) orthogonal polygons. d) non orthogonal polygons of “basket ball” type.

Preliminary results and discussion

The southern water ice margin between 30º S to 80º S covers a vast area and contains many different geological locales. Craters of different sizes are abundant and the main geomorphic feature. The main temporal domains are from the Noachian and Hesperian. The elevation which is generally high is punctuated by the two impact basins of Argyre and Hellas.

Polygons have been known since the Viking era and they have been described by several authors [7,8]. Global distributions have been presented by [9, 10, 1] and more thorough analysis of morphology has been done by [11, 12].

The distribution of our catalogued polygons display a striking latitude dependence (fig 2) hence verifying previous work. The diverse morphologies of polygons show different distributions. This could point to formation during different climate conditions, an idea further developed by [12].

Random orthogonal morphology

Polygons of this class occur as nets of cracks often displaying several hierarchies of polygon formation (fig 1a). They resemble terrestrial thermal contraction
polygons even though the nature of the wedge filling is so far unknown.

Orthogonal morphology
Terrestrial orthogonal polygons mostly occur adjacent to bodies of water and are due to the thermal gradient in the ground affected by the water. On Mars they are mostly intra crater landforms (fig. 1b-c).

Non orthogonal morphology
Catalogued non orthogonal polygons is mainly the type of formation previously described as “basket ball terrain” due to the likeness to the surface of a basket ball [11]. [11] describe these as sublimation polygons due to a striking resemblance to polygons found in Dry Valleys Antarctica (fig. 1d).

Work in progress
Argyre area and towards the South Pole
We are currently performing a detailed investigation of the Argyre area 325° - 335° E and 30° S – 90° S using MOC, HRSC, THEMIS and MOLA data. The area was chosen due to a wide diversity of periglacial landforms [5], the large variation in elevation, and the hypothesized past glacial and hydrologic history [13]. The focus of this work is periglacial landforms in general and polygonal patterns in particular and how they are influenced by changes in latitude. One addressed question of interest is of micro climate zonation as put forward by [14].

References

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