DISTRIBUTION AND MORPHOLOGY OF POLYGONS, SOUTH POLAR REGION, MARS. S. van Gasselt, D. Reiß, R. Jaumann, German Aerospace Center DLR, Institute of Planetary Research, D-12489 Berlin, Germany (Stephan.vanGasselt@dlr.de).

Abstract: In this work we present a mapping of polygonal patterns at the south pole of Mars between 80°-90°S on the basis of all MOC narrow angle images (up to the current release of E18). We found 750 (out of 6000) MOC narrow angle images showing a variety of polygonal patterns resembling terrestrial ice wedge polygons. They occur predominately inside circular depressions of the polar layered deposits, circum polar troughs and re–entrants or below slopes.

Introduction: Small–scale polygonal patterns have been observed in Viking Lander imagery [1]. Their morphology and development have often been ascribed to contraction cracking processes, analogous to terrestrial ice wedge polygons and are an indicator for the presence of subsurface water [e.g., 2]. With high resolution imagery from the Mars Orbiter Camera the features have been mapped and classified on a global scale by [3] and [4]. The main focus on analyzing the origin of polygonal patterns has been put on their distribution at southern and northern latitudes of > ±40°N. In this work we provide a detailed mapping of polygonal patterns at the south pole of Mars (s. fig. 1). The patterns are described on the basis of morphology and distribution.

We have mapped polygonal crack patterns on MOC narrow–angle imagery (up to E-18 release) and combined the results with color–coded MOLA digital elevation models superimposed on the MSSS MOC wide–angle MC–30 imagemosaics.

Geologic Setting and Observations: According to the geologic mapping of [5] the south polar region between 80°S and 90°S consists of the residual ice cap (Api) shifted towards longitudes between 0°W and 90°W. The remaining area is mainly covered by the Amazonian aged polar layered deposits (Apl) with small patches of non–polar related plains unit (s. fig. 1) At longitudes between 265°W and 90°W parts of the upper and lower Hesperian aged Dorsa Argentae Formation are exposed (Hdu, Hdl). The lateral distribution of this unit is equivalent to the area of low elevation (1200 m, blue color, s. fig. 2). At 10°W and between 70°W to 95°W remnants of the undivided Hesperian and Noachian material (HNu) which has undergone degradation processes by removal of ground ice, mass wasting and eolian removal occur. We observe several regions (marked A–E, s. fig. 1) with clusters of polygonal patterns in MOC imagery. The distinct circum polar distribution (D) of polygonal patterns at 87°S is due to the dense coverage of imagery. The circum polar distribution at 87°S does not continue on the surface of the residual polar cap but spreads along circum polar troughs (C). Especially at longitudes >270°W the polygons are bound to the polar troughs, where (a) the trough material is older than the polar layers at the surface, (b) degradation and removal

Figure 1: Simplified geologic map of the south polar region between 80°S and 90°S (after [5]) with polygonal crack patterns outside the polar cap. Letters represent areas discussed in the text.

Figure 2: South polar topography and distribution of polygonal crack patterns at the south pole between 80°S and 90°S. Blue dots represent polygonal patterns associated with circular depressions [6] on the residual polar cap.
of material has not yet advanced as far as at the surface, and (c) only a few layers of the polar layered deposits show the typical polygonal pattern. The layers containing polygons are exposed at the Chasma Australe walls, the eastern chasmatas, and inside depressions of the polar layered deposits at 180°W to 200°W. At 80°W the circum polar distribution furcates to the north and presents a large cluster of polygonal patterned ground in undivided Hesperian aged units (B).

Figure 3: Plains units polygons at 80°S (A on fig. 2). The black bar represents 200 m, north is up. Polygons of the south polar plains units occur predominately in sheltered places at slopes and inside of depressions.

Small quantities of polygonal terrain is visible on material of the Dorsa Argentae Formation (E), where it is bound to small depressions and rough terrain. Minor clusters of polygonal terrain is exposed adjacent to undivided plain units (A). Polygons related to plains units (A) are randomly orthogonal and highly complex shaped (s. fig. 3). They are degraded and occur south of sheltered slopes or inside depressions. Their diameter varies between 10 to 50 m but reaches up to 80 m. The polygonal troughs are filled with bright material, which might be associated with CO₂ frost [7]. Towards the pole polygons are orthogonal and their shape becomes more distinct with a preferred N–S direction. The polygonal troughs are filled with dark eolian material. Their diameter increase up to 100 to 200 m. Polar troughs related polygons (s. fig. 5) occur on the slopes and inside the troughs.

Figure 4: Randomly orthogonal and complex polygons of the Dorsa Argentae Formation (Hdl, Hdu) near 84°W and 80°S. The black bar represents 200 m, north is up.

They have an orthogonal shape and diameters between 10 m to 20 m. Outside the troughs the polygons disappear below eolian material. Polygons of undivided material near 84°W and 80°S are, similar to the plains units, more complex shaped and randomly orthogonal (s. fig. 4). Polygons exposed at the eroded wall material of the polar layered terrain occur on a few layers only. These polygons are partly degraded but show a distinct orthogonal pattern and sizes in a range of 20-40 m.

Figure 5: High resolution imagery of polar trough related polygonal networks near 85°W and 86°S. The black bar represents 200 m, north is up.

Conclusions: The distribution of south polar polygons is bound to circum polar troughs, polar re–entrants and depressions where polar layers are exposed (Apl). Polygonal patterns associated with circular depressions can be observed on the polar residual cap. Furthermore, clusters of polygonal patterns are distributed at undivided (HNu) and unclassified plains material. Polygons have a distinct shape and morphology according to their geologic and geomorphologic setting, although transitional morphologies occur in all units. As the distribution is not random at all, surfaces (especially few marker horizons of the layered terrain) showing polygonal patterns might have ages which are valuable to for implications on the past climate. Further research regarding ages is underway.

As far as insights have been provided by MOC, there are major dependencies on parameters like topography, homogeneity of (sub-)surface material, temperature changes, and exogenic degradation processes. Changes in these parameters will affect the growth, size, pattern and distribution of the polygonal networks [8]. Providing a complete coverage, color, and stereo information at high resolution, Mars Express will help to close the remaining gaps and to determine surface and morphologic properties to rule out some of the unknown parameters.