PRELIMINARY GEOLOGICAL ANALYSIS OF POLYGONAL IMPACT CRATER DATA FROM ARGYRE REGION, MARS. T. Öhman[1,2], M. Aittola[2], V.-P. Kostama[2] and J. Raitala[2]. [1]Department of Geosciences, Division of Geology, P.O. Box 3000, FI-90014 University of Oulu, Finland, <teemu.ohman@oulu.fi>; [2]Department of Physical Sciences, Division of Astronomy, P.O. Box 3000, FI-90014 University of Oulu, Finland

Introduction: Even fresh, uneroded impact craters are not always circular or elliptical. In fact, craters that are distinctly polygonal in plan view are common throughout the Solar System (see [1] for a short review). This polygonality is neither caused by erosion, nor does it arise from – although its patency certainly is affected by – the illumination geometry of the dataset used [2]. Thus, it most likely originates from the cratering process itself [2,3], probably by means of preferential excavation (simple craters), and collapse of the rim along pre-existing fractures (complex craters) [4]. We have shown that there appears to be a match between polygonal crater rim segment directions and other indications of tectonism (e.g. graben and wrinkle ridges) around the Hellas and Isidis basins in the southern hemisphere of Mars [1], and that in the Argyre region the polygonal craters from same areas but of different ages – or at least of different erosional stages – have statistically similar rim strike patterns [2,3]. This tentative study is an attempt to see what geological insight can be gained from the study of polygonal craters in Argyre region, and whether or not the structural data provided by such a study is compatible with similar information from other sources.

Geological outline: The area of our current interest (26-58°S 10-74°W) was studied mainly from Viking MDIM2 photomosaics with a resolution of about 231 m/pixel at the equator. The study area spans over the Early Noachian Argyre impact basin, the geological evolution of which has been a very complex one, and mainly dominated by glacial and fluvial/lacustrine processes [5 and references therein]. The Tharsis bulge lies to the northwest, and Valles Marineris to the north-northwest from our study area, both apparently affecting to its evolution. According to the map of Scott & Tanaka [6], the vast majority of polygonal craters are located in different units of Noachian cratered plains, while a significantly smaller number can be found from various Hesperian plains units. Most of the graben and wrinkle ridges found in the area are located in the northwestern part.

Results and discussion: Fig. 1a depicts the results of preliminary measurements of the wrinkle ridges' strikes in 042°–074°W 26°–42°S, while Fig. 1b holds the tentative information from graben in the same area. The ridges have northeasterly strike, typical for Solis and Felis Dorsae [6], while the graben follow the general ESE strike of Valles Marineris.

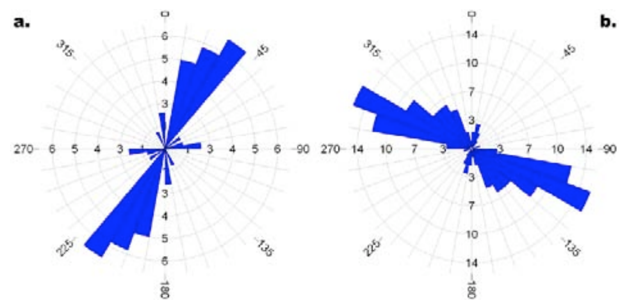


Fig. 1. The number of preliminary strike measurements of ridges (a; n=25) and graben (b; n=68) NW from Argyre basin. Compare with Fig. 2.

Fig. 2 presents the rim strike measurement data from polygonal craters of three erosional stages [2], i.e. heavily eroded (rimless; Fig. 2a), rimmed (Fig. 2b) and fresh (Fig. 2c). The eroded craters provide relatively few measurements (n=36) thus making interpretations uncertain, but the rimmed craters (n=115) display a typical pattern with three main strikes. These directions are probably linked both to the basin – as was the case around Hellas and Isidis [1] – as well as to Valles Marineris, although it must be noted that the graben strikes peak at around 100º–130º, while crater rim strikes peak at 080º–100º and at 130º–150º. The exact nature of this small but intriguing discprepancy remains so far unexplained. In the Hellas region graben and crater rim strikes were found to have a better correlation [1]. Some of the discrepancy could by explained by the preliminary nature of the graben measurements.

The data from fresh craters (Fig. 2c) having a preserved ejecta blanket also suffer from a limited number of measurements (n=26), but the clustering around 010º–040º is apparent. Interestingly this direction matches with the strike of ridges. As fresh craters and wrinkle ridges both are geologically quite recent, it is tempting to assume that the origin of the rim strikes of polygonal craters and the strike of the ridges both reflect the same structural pattern of the target material. Results with same implications were gained also from Hesperia Planum [1].

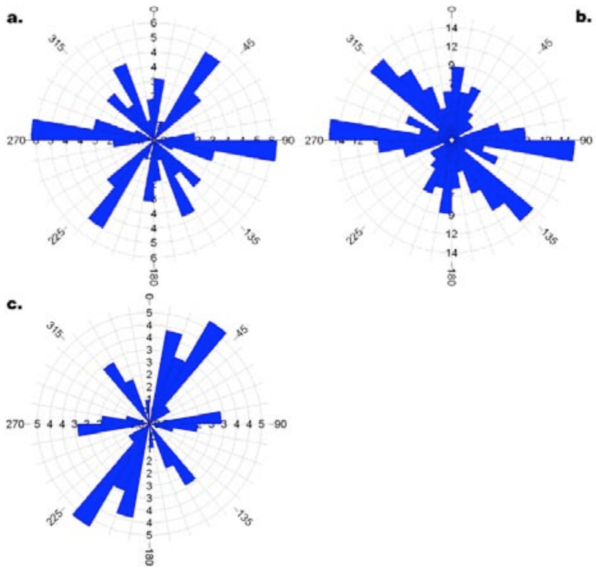
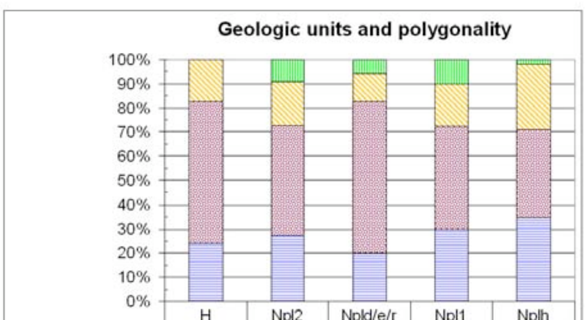


Fig. 2. The number of straight rim segment strike measurements of eroded (a; n=36), rimmed (b; n=115) and fresh (c; n=26) polygonal impact craters NW from Argyre basin. Note the low number of measurements in (a) and (c). Compare with Fig. 1.



	H	Npl2	Npld/e/r	Npl1	Nplh
5-6 straight sides	0	3	2	12	1
4 straight sides	5	6	4	21	14
3 straight sides	17	15	22	51	19
2 straight sides	7	9	7	36	18
total number	29	33	35	120	52

Fig. 3. Given the varying number of polygonal craters in each of the geological units [6], the percentages of polygonal impact craters of different polygonality classes appear to be roughly the same in different units. Note that all Hesperian units, as well as some of the Noachian units are grouped together.

Fig. 3 shows the percentages of craters with a different number of straight rim segments, classified by the geological unit [6] they are now located in. Although we have yet to perform statistical tests, it appears that there is no significant correlation between the amount of polygonality (as measured by the number of straight rim segments) and the geological unit. It ought to be borne in mind that the geological units describe only the surface and that the structures beneath the surface affecting the formation of the craters can be substantially older and/or different. In any case at this point it seems that no firm classifications on the nature of the material unit (e.g. how fractured it is) in which a population of polygonal craters is now situated, can be based on the amount of the craters' polygonality. It therefore currently appears that in the scale revealed by the analysis of polygonal craters, all areas regardless of their assigned geologic units are similarly fractured (see [1] for a short discussion on the effect of e.g. joint spacing).

Summary and conclusions: Our work on the our conviction that polygonal craters reflect the structural pattern of the target material – manifested also by e.g. ridges – and thus can be used in unraveling the geologic history on a regional scale. However, the geologic units seem to have no correlation with the amount of polygonality.

Future tasks: While finishing our study on the geological implications of the polygonal crater data from the Argyre region, there are also other aspects we are contemplating. The effect of the crater size on the crater's polygonality is an interesting and complex [1] issue we wish to elucidate, and thus also gain a deeper understanding of the cratering process. In addition, Mars Odyssey THEMIS and Mars Express HRSC images can provide a more sound basis for geological mapping than the use of mere Viking data, therefore offering a possibility for more justified arguments on the possible effect of target material to the amount of polygonality.

References: [1] Öhman T. et al. (2005) In: Koeberl C. & Henkel H. (eds.) *Impact tectonics,* Springer, 131–160. [2] Öhman T. et al. (2006) submitted. [3] Öhman T. et al. (2006) *Bull. Geol. Soc. Finland, Special Issue 1,* 176. [4] Eppler D. T. et al. (1983) *GSA Bull., 94,* 274–291. [5] Hiesinger H. & Head III J. W. (2002) *PSS, 50,* 939–981. [6] Scott D. H. & Tanaka K. L. (1986) *Geologic map of the western equatorial region of Mars*, Map I-1802-A. U.S. Geological Survey.

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