GIANT LOWLAND POLYGONS: RELICS OF AN ANCIENT MARTIAN OCEAN?. S. C. Werner, S. van Gasselt, G. Neukum, *Department of Earth Sciences, Freie Universitaet Berlin, Germany (swerner@zedat.fu-berlin.de).*

Introduction: Utopia and Acidalia Planitae are occupied by extensive areas of polygonal terrain, so–called giant polygons. They consist of 200 to 800 meter wide steep–walled and flat–floored troughs some tens of meters deep and 5 km to 30 km in diameter. A number of hypotheses for the origin have been discussed such as thermal cooling and contraction in permafrost, desiccation of water–saturated sediments, cooling of lava, and tectonic deformation. Pechmann [1] has shown that none of these terrestrial analogs would lead to a satisfactory description of the mechanisms and scales involved. McGill and Hills [2] besides others were able to explain the observed large size of the polygons and could account for the stresses responsible for the polygonal troughs by plate-bending and finite-element models which indicate the shrinkage of desiccating sediments or cooling of volcanics accompanied by differential compaction over buried topography. A primary tectonic origin being caused by uplift of the basin floor in the Utopia region has been discussed [3]. The giant polygonal pattern is accompanied by ring– or double–ring–like structures which are assumed to be buried craters (ghost craters) and have been used to estimate the thickness of the overburden.

Geologic Settings: Following the geological interpretation by [4,5] the polygonal terrain material was deposited in the late Hesperian. The age relation of troughs to superimposed craters indicate that the polygon formation occurred immediately after the deposition [6]. Lucchitta et al. [7] advocate the material being of sedimentary origin deposited in a standing body of water and emphasize the areal correspondence between topographic low regions in the northern plains, polygonal terrain and outflow channels. Carr [8] describes the capability of the outflow channels to supply immense volumes of wet sediments to the lowland region. Crater counts indicate a coincidence between outflow events and origination of the polygonal terrain [9]. Age determination [10] indicated that the channels which might have fed the lowland region were cut into a surface that is younger than the polygonal terrain.

Crater Counts on Giant Polygon Terrain: We performed new measurements in selected areas of the Utopia region which cover polygonal terrain and surrounding units (Fig.1). All crater size–frequency distributions (SFD) of the selected units converge in the smaller–crater diameter size range and give an age of 3.4 Ga. The diversity or deviation from the expected crater production function [11,12] for the larger–crater diameter size range (larger than 3 km) depends most likely on different target properties or the geologic evolution of that area. A few of these units show an "excess" in the crater SFD of larger craters (Fig. 1, Unit G) which has been already observed by [10]. Crater counts on these units yield an age of 3.8 Ga. The measured distributions converging in the small-size range lead to an age of 3.4 Ga and indicate a resurfacing event at 3.4 Ga ago detectable in all units.

Results: Investigating the region of polygonal terrain in the Utopia and Acidalia Planitiae we obtain SFDs which appear to have an unusual deficiency of large craters compared to the proposed production function. This unusual lack of larger craters is interpreted to be due to target property effects in the cratering process leading to different crater morphologies and sizes. For the polygonal terrain in Utopia Planitia first we measured the crater size- -frequency distribution of the clearly visible craters and obtained an age of 3.4 Ga. The same distribution has been combined with the population of so-called ghost craters, the buried craters which cause the ring–like grabens. The sum of visible and ghost crater populations yield an age of 3.8 Ga as it has been observed in regions with strong excess of craters in the larger diameter range (Fig. 2). In the Acidalia Planitia case the crater SFD show similar results, but appear less pronounced (Fig. 3). The ages for this region are slightly different and yield a time span from 3.5 to 3.7 Ga.

Interpretation: Whatever causes the diversity or obscures the expected production function of the crater SFD in Utopia Planitia in the larger–size range occurred between 3.4 and 3.8 Ga. The crater SFDs of Acidalia Planitia support the results.

These distributions can be explained by extensive resurfacing effects within a time span of roughly half a billion years. This is consistant with the existence of a proposed ocean in the northern lowlands [e.g. 7] and with the interpretation that the polygons formed through desiccation and differential compaction of sediment over buried topography.

References: [1] Pechmann (1980) Icarus 42, 185-210; [2] McGill and Hills (1992) JGR 97/E2, 2633-2647; [3] Hiesinger and Head (2000) JGR 105/E5, 11999-12022; [4] Scott and Tanaka (1986) Geologic Map of the western equatorial region of Mars, USGS I-1802-A; [5] Greeley and Guest (1987) Geologic Map of the eastern equatorial region of Mars, USGS I-1802-B; [6] McGill (1986) GRL 13, 705-708; [7] Lucchitta, Ferguson and Summers (1986), 17th LPSC, JGR 91/1 Supp. E166-E174; [8] Carr (1986) Icarus 68, 187-216; [9] Neukum and Hiller (1981) JGR 86, 3097-3121; [10] McGill (1988) LPI-MEVTV Workshop, 91-93; [11] Neukum, Ivanov, and Hartmann (2001) Space Sci. Rev. 96, 55-86; [12] Ivanov (2001) Space Sci. Rev. 96, 87-104.

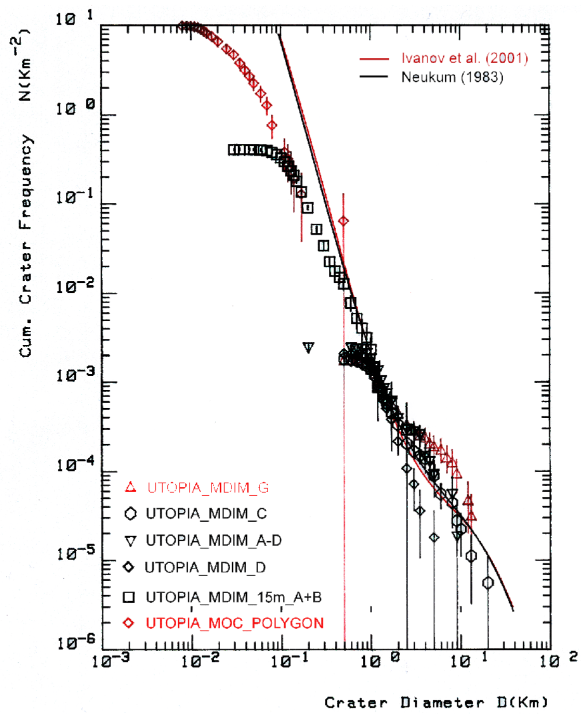

Figure 1: The crater size–frequency distribution of selected areas in Utopia Planitia show a diversity in the large–crater diameter size range and a convergence in the small–crater diameter size range (roughly smaller than 2 km).

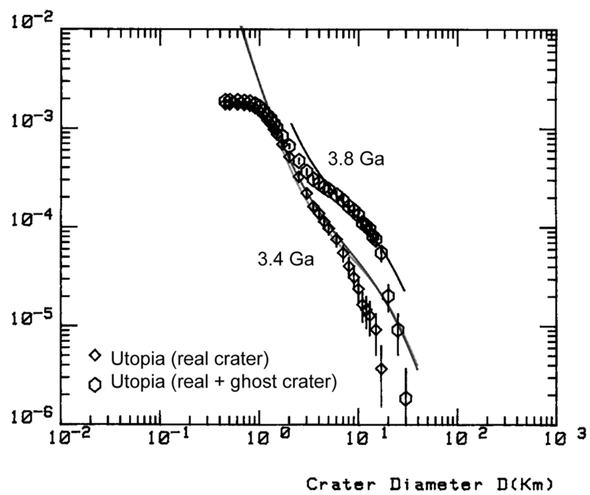

Figure 2: The crater size–frequency distribution in the polygonal terrain of the Utopia basin region is shown with and without the contribution of the ghost crater population.

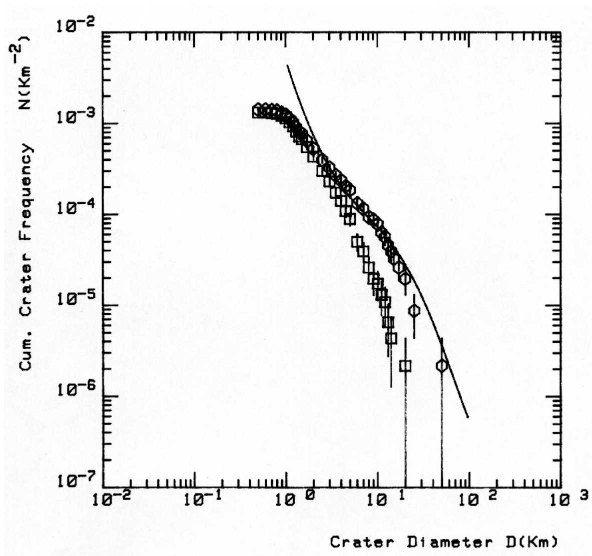

Figure 3: The crater size–frequency distribution in the polygonal terrain of the Acidalia region is shown with and without the contribution of the ghost crater population. The effect is similar to the Utopia basin but not as pronounced.