Geophysical Research Abstracts,
Vol. 11, EGU2009-11129-1, 2009
EGU General Assembly 2009

Absolute model ages of mantled surfaces in Malea Planum and Utopia Planitia, Mars.

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The surface of Mars is partially covered by a latitude-dependent ice-rich smooth mantle in the middle and high latitudes (±30-60°) [1, 2]. These deposits relate to changes in the obliquity of Mars which have led to major shifts in the Martian climate and repeated global episodes of deposition [3]. The deposits vary in thickness and are usually independent of local geology, topography and elevation. In this study we have determined absolute model ages for the mantled surface units in Utopia Planitia (northern hemisphere) and Malea Planum (southern hemisphere) using crater statistics [4]. These regions show a specific type of mantle degradation called scalloped terrain, and modelled crater retention ages of the easily eroded mantle in these regions reveal the time since the last resurfacing.

Images from the High Resolution Imaging Science Experiment (HiRISE) (25-50 cm/pixel spatial resolution) on board the Mars Reconnaissance Orbiter (MRO) were analyzed, continuous areas of smooth mantle were mapped, and small, fresh, unmodified craters were counted. Both regions show degradation features of the mantle in varying degrees. The mantle in Utopia Planitia appears heavily modified by polygonal fractures and scalloped depressions [5]. Scalloped depressions are also found in Malea Planum, but the mantle appears much smoother and less modified by periglacial processes [5, 6]. The study areas totalled 722 km^2 in Utopia Planitia, and 296 km^2 in Malea Planum. Model ages for these regions were determined using the chronology function of Hartmann and Neukum [4] and the production function Ivanov [7]. The model ages show that the mantle unit for the area mapped in Utopia Planitia is 0.65 (+0.35/-0.41) to 2.9 (+0.69/-0.75) Myr old and Malea Planum is 3.0 (+1.5/-1.7) to 4.5 (+1.3/-1.4) Myr old, and that both regions represent very recent Amazonian terrain. This is also in agreement with the observed young degradation features described by [6, 8].

We acknowledge that the relatively small size of the study regions and the possibility of small secondary impact craters, can enlarge the uncertainties to our crater statistics. Additionally, subsequent periglacial degradation of the surface has possibly eroded craters to the point they are not recognized. This would result in a loss of counted craters, and an underestimation of the age. This is especially problematic in Utopia Planitia where the mantle is degraded by polygons and pits. Based on visual inspection, the mantle material on Malea Planum appears much smoother and fresher than that in Utopia Planitia, which would suggest that less modification has taken place, and thus less time since resurfacing. However, our modelled ages imply that Utopia Planitia is younger. Nevertheless, the results suggest that the mantle deposits are very young and probably related to recent climate changes on Mars. Investigations by Head et al. [2] using models from Laskar et al. [9] concluded that mantle deposition and degradation are connected to obliquity-driven glacial and interglacial stages, with the most recent depositional phase between 0.4-2 Myr ago. Levrard et al. [10] also suggested that the formation of the uppermost part of the mantle is connected to obliquity changes, probably within the last 3-5 Myr. Our initial results for the time since the last resurfacing support these interpretations, and will be further constrained by additional analysis as new images become available.

[1] Mustard et al., 2001, Nature, 412; [2] Head et al., 2003, Nature, 426; [3] Milliken and Mustard, 2003, Sixth International Conference on Mars; [4] Hartmann and Neukum, 2001, Space Science Reviews, 96; [5] Lefort et al., 2007, LPSC abs #1796; [6] Zanetti et al., submitted to Icarus; [7] Ivanov, 2001, Space Science Reviews, 96; [8] Morgenstern et al., 2007, Journal of Geophysical Research-Planets, 112; [9] Laskar et al., 2004, Icarus, 170; [10] Levrard et al., 2004, Nature, 431