AGES OF RAMPART CRATERS IN THE XANTHE TERRA REGION AND SOUTHERN CHRYSE PLANITIA, MARS: IMPLICATIONS FOR THE DISTRIBUTION OF GROUND ICE IN EQUATORIAL REGIONS.

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Introduction: Many large craters on Mars exhibit ejecta blankets which are not observed on other terrestrial planets like the Moon [1]. As found by many researchers [e.g. 2, 3, 4] the morphology is suggested to be caused by volatile rich target material [2] or atmospheric effects [5]. However, in a given area a certain minimum diameter exists for craters which show fluidized ejecta blankets [6, 7], called the onset diameter. Geographic mapping shows a latitude dependence of the onset diameters [8, 9]. In equatorial regions the onset diameters are typically 4 to 7 km versus 1 to 2 km in high latitudes (50° Lat.) which might indicate a ice rich layer in depths of about 300 to 400 m near the equator and ~100 m at 50° latitudes [8]. As pointed out by [1] rampart craters may have formed over a significant time interval and therefore reflect the ground ice depths at a given time.

We determined the absolute ages of rampart craters in two near equatorial regions on Mars by measuring the ejecta blankets superposed crater frequencies in Mars Express High Resolution Stereo Camera (HRSC) imagery [10]. The images used for our measurements have a resolution between 12 to 15 m/pxl and cover large areas (~10^5 km^2) which allows us to determine small-crater diameters and to work in a regional context.

Geological Context: The study regions are located in the Xanthe Terra Region between Maja Vallis to the west and Shalbatana Vallis to the east (0°-15°N and 310°-314°E) and southern Chryse Planitia west of the Pathfinder landing site (11.8°-25.6°N and 324.5°-326.7°E) (Figure 1).

The Xanthe Terra region lies in the Noachian-aged subdued cratered unit (Npl2) [11]. Several valley networks (Nanedi, Hyphanis and Sabrina Vallis) cut the region. The valley formation might have begun in the Noachian and continued into the Early Hesperian [11,12]. The study area of southern Chryse Planitia (west of the Pathfinder landing site) covers the northern part of the outflow channel Tiu Vallis. Based on stratigraphic superposition of the circum-Chryse outflow channels Tiu Vallis shows the youngest relative age [13, 14, 15]. Absolute age determinations [16, 17] revealed that fluvial activity of Tiu Vallis occured in the range between ~3.5 to ~2 Gyr [16] and ~3.6 to ~1.5 Gyr BP [17].

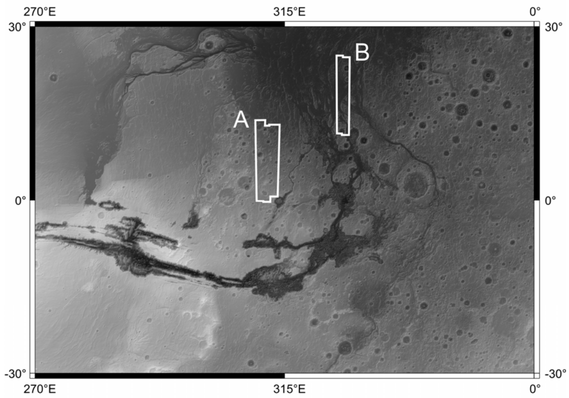

Figure 1. *Regional context of the study areas. HRSC-image mosaic of Orbits 927, 905 and 894 in the Xanthe Terra region **(A)**; HRSC-image mosaic of Orbits 1143 and 1154 in southern Chryse Planitia **(B)**.*

Methodology: To determine the absolute model ages of the rampart craters we counted the crater frequencies on the ejecta blankets utilizing the the Martian impact cratering model of [18] and the polynomial coefficients of [19].

Results and Discussion: Ages of rampart craters in the Xanthe Terra region (Figure 2A and 3A) are in the range of ~4 to ~3 Gyr. Most absolute model ages of individual ejecta blankets are around 3.8 Gyr. The derived ages imply that their formation is connected with the Noachian aged fluvial activity (~3.8 Gyr) in this region [12]. The formation rate of rampart craters declines in the Hesperian, whereas onset diameters increase. At the Hesperian-Amazonian boundary the formation comes to an end. This might indicate a lowering of the ground ice table with time which could be in Xanthe Terra, if present at all, several kilometers deep in present days. Either all ground ice is lost with time due to diffusion to the atmosphere [e.g. 20] or there is still a deep ground ice layer which can only be reached by relatively large (and in recent times rare) impacts.

In southern Chryse Planitia the rampart craters which ejectas are eroded by fluvial events show absolute model ages around 3.8 Gyr and between ~0.5 to ~1.5 Gyr of channel superposed ramparts (Figure 3B). These ages are in good agreement with the fluvial activity of Tiu Vallis derived from crater counts [16, 17].

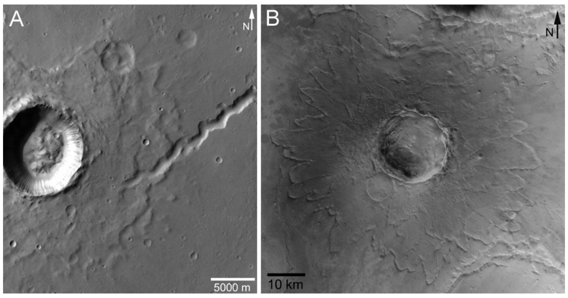

Figure 2. *Rampart crater in the Xanthe Terra region with an absolute model age of ~ 3.8 Gyr (HRSC-orbit 927 at 5°N and 310°E). A lateral valley of Nanedi Vallis eroded into the ejecta after the formation of the rampart **(A)**. Rampart crater Yuty in the southern Chryse region with an absolute model age of ~2.2 Gyr (Mosaic of HRSC-orbits 1143 and 1154 at 22.4°N and 325.9°E) **(B)**.*

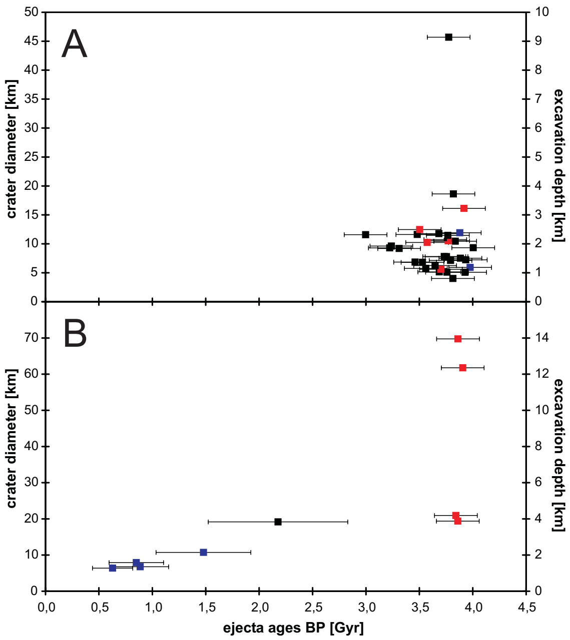

Figure 3. *Absolute model ages of Rampart craters versus crater diameter and excavation depth of the Xanthe Terra Region **(A)** and southern Chryse Planitia **(B)**. Blue squares show Rampart craters which are superposed on fluvial features. Red squares show Rampart craters which are eroded by fluvial activity. Black squares show no relative age relationships. Error bars are 30% for model ages younger than 3 Gyr and ±200 Myr for model ages higher than 3 Gyr [23]. The excavation depth is based on a depth- diameter ratio of 0.2 [24].*

The formation of young ramparts with onset diameters of ~6 km indicates that ground ice could still be present in this region at depths of a few hundreds of meters. The ground ice might be recharged by the last fluvial episode of Tiu Vallis and sheltered from diffusion by thick fluvial sediments. The volatile layer in Chryse Planitia in general could possibly be as shallow as ~60 m as measured onset diameters of [21, 22] indicate.

Conclusions: The distribution of present equatorial ground ice varies regionally. The correlation of rampart ages with fluvial activity and the lack of new fresh rampart craters in the Xanthe Terra region indicates that the ground ice table is possibly at a depth of several kilometers or non-existent at present times. In southern Chryse Planitia relatively young rampart craters with onset diameters of about 6 km formed after the last fluvial activity in this region. This indicates a ground ice table (possibly a few hundred metres deep) in recent geologically times which might be still present today.

Future Work: Future work will include investigating other equatorial regions on Mars with HRSC-images, e.g. Solis Planum, where smaller onset diameters than usual occur [25]. The identification of possible present ice-rich subsurface equatorial regions can be verfied by the upcoming MARSIS and SHARAD radar experiments.

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