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Rampart craters in Thaumasia Planum, Mars: Onset diameters, ages, and implications for the Hesperian hydrology

D. Reiss (1), E. Hauber (1), B. A. Ivanov (2), G. Michael (1), R. Jaumann (1), G. Neukum (3) and The HRSC Co-Investigator Team

(1) Institute of Planetary Research, German Aerospace Center (DLR), Berlin, Germany (dennis.reiss@dlr.de), (2) Institute of Dynamics of Geospheres, Russian Academy of Science, Moscow, Russia, (3) Institute for Geosciences, Freie Universitaet Berlin, Germany.

Many large craters on Mars exhibit ejecta blankets which are not observed on other terrestrial planets like the Moon. Their morphology is likely be caused by volatile-rich target material or possibly atmospheric effects. For a given area a certain minimum diameter exists for craters which show fluidized ejecta blankets (rampart crater), called the onset diameter. Geographic mapping showed a latitude dependence of onset diameters. In equatorial regions the onset diameters are typically 4 to 7 km versus 1 to 2 km in high latitudes (50° latitude), which indicates an ice rich layer at depths of about 300 to 400 m near the equator and about 50 to 100 m at 50° latitude. Rampart craters may have formed over a significant time interval and therefore reflect the ground ice depths at a given time. We analyzed the onset diameter, ages and depth-diameter ratios of rampart craters in the Thaumasia Planum region which is located south of Valles Marineris and east of Sinai and Solis Plana (285°E to 305°E and 30°S to 18°S). The region mostly consists of older ridged plains material (unit HNr). We mapped all rampart craters on the geologic unit HNr in the study region, where HRSC-coverage was available. 86 rampart craters were identified on the available image data in the geologic unit HNr. The crater diameter ranges from ∼1 km to ∼30 km. A large number (30) of small rampart craters (1 km - 3 km) with an onset diameter of 1 km occur in the Thaumasia Planum region. The rampart craters in Thaumasia Planum show absolute model ages between ∼3.75 Ga and ∼3.15 Ga (D = ∼4 km - ∼30 km). Most absolute model ages of individual ejecta blankets are around 3.6 Ga. The ages of rampart craters coincide with the formation of the geological unit

HNr at the Noachian/Hesperian boundary at around 3.7 Ga. However, the age of the smaller rampart craters ($\leq$ 5 km) can not be measured due to the small area of their ejecta blankets. Although the ejecta blankets are cratered and show some degradation, it is unclear when they were formed. The depth-diameter (d/D) ratio is one method to constrain the relative age of the small craters. The d/D relationship helps to assess erosional and infilling processes, which modified the rampart craters in comparison to fresh craters. Lower d/D ratios indicate older craters. On average the rampart craters have a depth-diameter ratio of $\sim$0.12 in contrast to general d/D relationships of $\sim$0.2 for fresh simple craters. This may indicate that the small rampart craters are old and were formed in the Hesperian like the larger rampart craters. The first results of this study suggest that the formation of rampart craters is connected to volatile rich periods in Thaumasia Planum, possibly related to the formation of the unit HNr. The observed small onset diameter (1 km) in this equatorial region on Mars was unknown before and indicates a shallow groundwater or ground ice table at the time of the impact. In contrast to the larger Hesperian-aged rampart craters, their age is uncertain. Although the degraded morphology of the ejecta blankets and the low d/D-ratio suggest the small rampart craters are old, further work is necessary to constrain their formation time.