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Chronology of wrinkle ridge formation and rate of crustal shortening on Lunae Planum, Mars

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The Lunae Planum, a plain between the Tharsis Montes and the Acidalia Planitia on Mars, represents a transitional zone from a volcanic rise to a lowland plain, respectively. From West to East at N20°, topography changes from 600 m to -750 m. Here, several wrinkle ridges that are compressional tectonic features formed by folding and thrust faulting [1], mark the surficial deformation of the martian crust. From the analysis of >25 wrinkle ridges in earlier studies a total shortening of ∼1840 m and a compressive strain of 0.29% has been suggested for the Lunae Planum [2].

In this study, we investigate the chronological order of geomorphic structures and determine the timing and duration of the crustal shortening of Lunae Planum. We use remote sensing mapping techniques [3] and crater size-frequency distribution measurements (CSFD) [e.g.,4,5]. In our analyses, we use HRSC (12.5 m/pixel), CTX (6 m/pixel) and HiRISE (0.3 m/pixel) satellite images and digital terrain models to document geomorphic structures such as wrinkles ridges, impact craters, crater ejecta blankets and intermontane plains. Our CSFD measurements of wrinkle ridges reveal an age distribution from ∼3.9 Ga to ∼3.0 Ga, with surfaces getting younger towards the East. Our findings are in accordance with earlier observations of greater shortening amounts towards the West (in older ridges) [2]. The age distribution of wrinkle ridges suggests a 9 Ma time interval for the proposed ∼1840 m horizontal shortening at a deformation rate of 2.04 x 10-3 mm/yr for compressional deformation on the Lunae Planum.

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