RIFTING ON MARS: IMPLICATIONS FOR EARLY LITHOSPHERIC AND CRUSTAL STRUCTURE.

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Introduction: Rift valleys on Mars have recently attracted considerable attention and thoroughly been investigated from a geological perspective [1,2]. Apart from Valles Marineris, Martian rifts resemble terrestrial continental rift structures with respect to key characteristics such as geometric dimension, fault pattern, morphology and the presence of rift related volcanism. However, the usually present footwall uplift was not observed. Contrary to previous studies, we have identified rift flank uplift at the Coracis Fossae, facilitating geomechanical modeling.

Observations: This study focuses on the eastern Coracis Fossae rift, a large extensional structure in the southern Thaumasia region on Mars (Fig. 1). The rift trends SW-NE, exhibits a complex morphology, segmented border faults arranged in en echelon pattern and fractured graben floors. The topographic rise labeled 'V' is interpreted as a possible volcano, indicating the presence of rift related volcanism.

Methods and Results: Using images acquired by the High Resolution Stereo Camera on board the Mars Express mission and evaluating crater statistics of the key surface units labeled in Fig. 1, the time of rift formation was constrained to 3.5-3.9 Gyr [3].

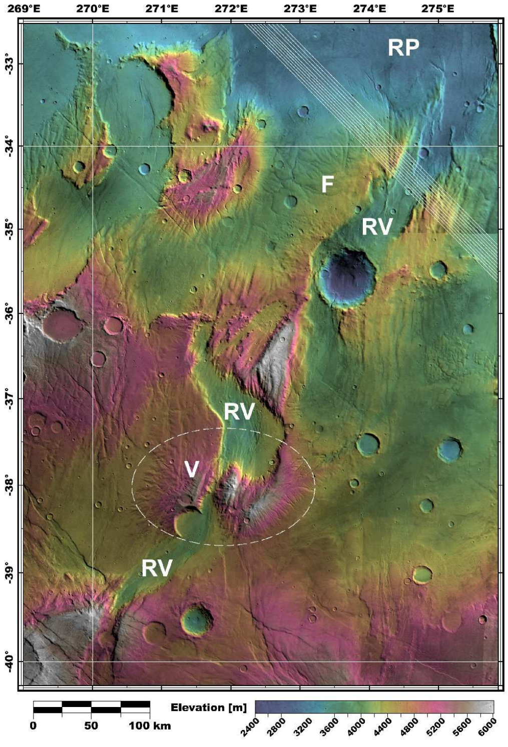

Figure 1: Topographic image map of the eastern Coracis Fossae rift.

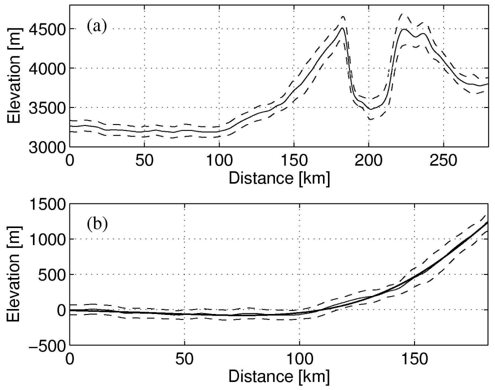

Figure 2: (a) Mean elevation as a function of distance along profiles (b) Flexural fit to the western rift flank.

Fig. 2 shows the stacked mean topographic profile and flexural fitting has been used to constrain the elastic thickness to 10.3-12-5 km. Using the strength envelope formalism [5] and assuming a diabase composition of the crust, this thickness is converted to a mechanical thickness of 15-19 km, corresponding to a geothermal gradient of 27-33 K km^{-1} [3].

Applying the pure shear model of lithospheric extension and evaluating the force balance during rifting [6], we then find that for the thermal gradient present at 3.5-3.9 Gyr the style of rifting is only compatible with the observations if the crustal thickness has not exceeded ~ 50 km [4].

Discussion: The thermal gradient determined here is higher than that usually assumed to be present in the Noachian period. However, since the time of rift formation falls within the time span of main activity in the Tharsis region, an increased heat flow can be expected.

Gravity and topography data imply a present day crustal thickness close to 70 km. This indicates that crustal production was not finished by 3.5-3.9 Gyr, a result supported by thermal evolution models and consistent with geochemical studies. Since surface expressions of substantial extrusive volcanism after 3.5 Gyr are absent, the rates of magmatic underplating must have been fairly large even after 3.5 Gyr.

References: [1] Hauber E. and Kronberg P. (2005), *JGR*, 110, E07003, doi:10.1029/2005JE002407. [2] Hauber E. and Kronberg P. (2001), *JGR*, 106, 20587-20602. [3] Grott M. et al. (2005), *GRL*, 32, L21201, doi:10.1029/2005GL023894. [4] Grott M. (2005), *GRL*, 32, L23201, doi:10.1029/2005GL024492. [5] McNutt M.K. (1984), *JGR*, 89, 11180-11194. [6] Buck W.R. (1991), *JGR*, 96, 20161-10178.