STRENGTH OF FAULTS ON MARS FROM MOLA TOPOGRAPHY. F. Nimmo, *Dept. Geological Sciences, University College London, WC1E 6BT, UK, (nimmo@gps.caltech.edu),* D. Barnett, *Bullard Laboratories, University of Cambridge, Cambridge CB3 0EZ, UK, (barnett@esc.cam.ac.uk).*

The stresses which must be maintained on faults bounding the rift topography at Tempe Fossae (the 'North Tempe Rift' (NTR)) and Valles Marineris (VM) on Mars are estimated, using a simple elastic model and topographic data from the Mars Orbiter Laser Altimeter (MOLA). For at least the NTR, and possibly VM, the faults need to be no stronger than terrestrial faults.

The North Tempe Rift is similar in appearance to terrestrial continental rifts (Hauber and Kronberg 2001). Topographic profiles across the NTR demonstrate an absence of rift flank uplift (see Fig 1). By calculating the theoretical uplift which would occur as a function of the elastic thickness, T_e, Figure 1 shows that the value of T_e is likely to exceed 20 km at the time of rift formation. Given the rift morphology and a value for T_e, the maximum resolved shear stresses which occur on any faults present may be calculated (Foster & Nimmo 1996). These shear stresses increase with rift width λ and vertical relief $2h$ but decrease with increasing T_e. Figure 2a shows how the shear stresses vary with λ and T_e and demonstrate that they are unlikely to exceed 20 MPa (see Figure 2).

On Earth, maximum shear stresses calculated in the same way are around 10 MPa (Jackson & White 1989) and are similar to the maximum stress drops during earthquakes. These observations suggest that the maximum strength of faults on Earth is $\sim$ 10 MPa. The above results imply that the Martian faults at NTR are not significantly stronger than terrestrial faults.

Elastic thickness estimates at VM are mostly around 50 km or greater (McGovern et al. 2001, Zuber et al. 2000). For the observed present-day canyon widths of $\sim$ 400 km, the bounding faults of VM, if present, must be able to withstand stresses of up to approximately 100 MPa (see Figure 2b). Either (1) the strength of faults on Mars varies spatially or temporally (2) VM was not primarily caused by faulting or (3) the morphology of VM has been significantly altered since it formed. Geomorphological analysis (e.g. Schultz & Lin 2001) suggests that the latter may be correct; if the fault-controlled sections of the canyons do not exceed 150 km in width, the fault strength required is only 20 MPa.

At least some faults on Mars are no stronger than similar features on the Earth. This observation is consistent with the existence of liquid water in the shallow subsurface of Mars at the time the faults were active. On Venus, plate tectonics is probably prevented by the frictional resistance to motion across strong faults. On Mars, it is more likely that the large thickness of the elastic layer of the lithosphere and the possible positive buoyancy of the crust are responsible for the observed lack of plate tectonics.

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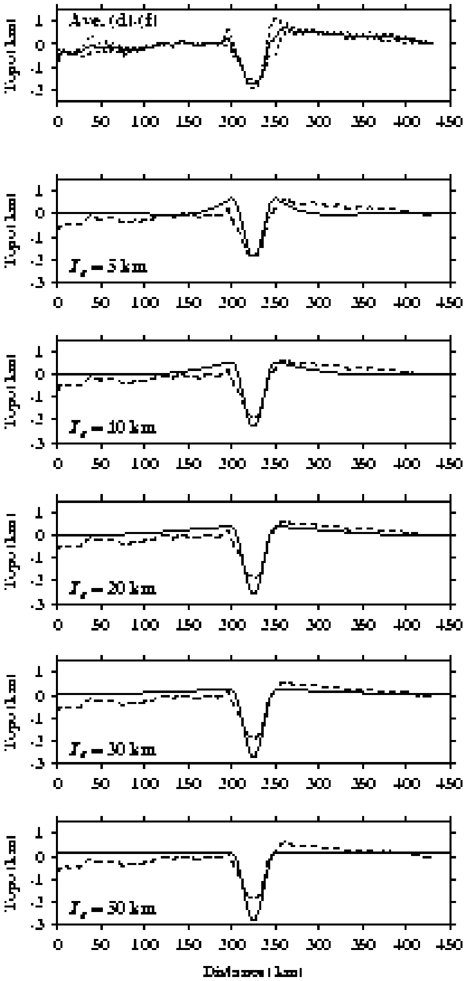

Figure 1: Topographic profiles across the North Tempe Rift (NTR), taken from the $\frac{1}{16}$° resolution topographic model, IEG0062T (Smith *et al.* 1999a). The vertical exaggeration is about ×26. The lowermost five plots show the resulting topography when a 3 km deep cosinusoidal trough, with width 50 km (i.e. similar to the dimensions of the NTR) is emplaced on a plate of varying elastic thickness, T_e. The plate deflection was calculated according to the method of McKenzie & Bowin (1976), using a thin plate approximation (Le Pichon *et al.* 1976). These may be compared with the top plot, which shows the average of topographic profiles across the NTR (solid line) and also the topography plus and minus its standard deviation at each point (dotted lines). The average profile is also shown as a dashed line in the other plots.

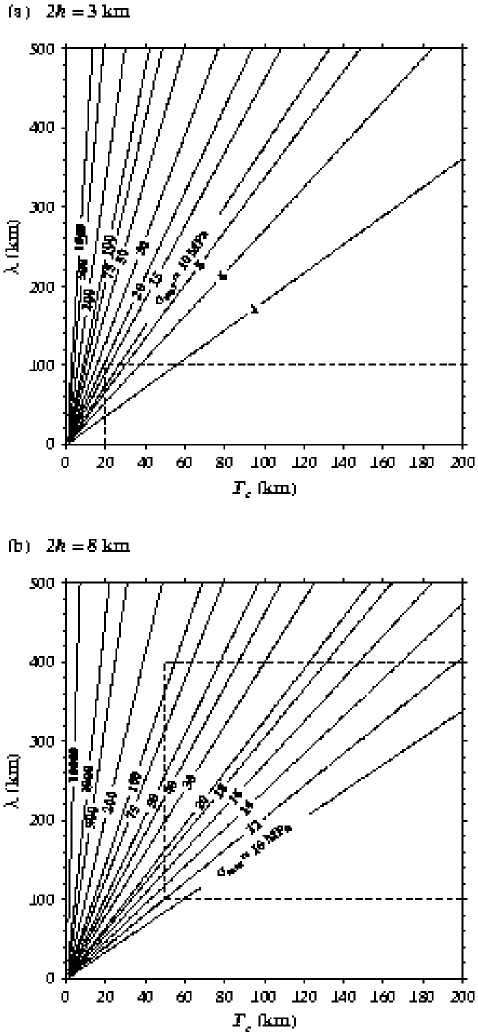

Figure 2: Plots of the maximum shear stress, σ_{max}, (in MPa) as a function of wavelength, λ and elastic thickness, T_e, calculated using the same method as Foster & Nimmo (1996). For case (a) the total vertical offset $2h = 3$ km (i.e. appropriate for the NTR) and for (b) $2h = 8$ km (i.e. appropriate for VM). The areas enclosed by dashed lines represent the regions of parameter space which are likely to be appropriate for the features in question.