SUPPORT OF TOPOGRAPHIC AND OTHER LOADS ON THE MOON AND MARS. D.L. Turcotte and R.J. Willemann, Department of Geological Sciences, Cornell University, Ithaca, New York 14853.

The existence of the mascons on the moon indicate that the lunar elastic lithosphere can support substantial loads. Lunar topography also appears to be uncompensated. Observations of gravity on Mars show that the Tharsis uplift is only partially compensated. A number of authors have attributed this support to the bending of the elastic lithospheres (1-5). Through a series of analytical studies (6) we have shown that membrane stresses can support topographic loads on the moon and Mars.

The governing parameter that determines the ability of a planetary shell to support loads by membrane stresses is $\tau = Ed/\Delta\rho g R^2$ where E is Young's modulus, d the thickness of the shell, g the surface gravity, R the radius of the body and $\Delta\rho=\rho_m-\rho_c$ for topographic loads (ρ_m = mantle density, ρ_c = crustal density) and $\Delta\rho=\rho_m$ for non-topographic loads, i.e. mascons. For the moon we take $E=6\times10^{11}$ dynes/cm^2, $\rho_m=3.3$ gm/cm^3, $\rho_c=2.8$ gm/cm^3, $g=165$ cm/s^2, $R=1738$ km and find that $\tau=0.5$ corresponds to $h=21$ km for topographic loads and $h=137$ km for non-topographic loads. The conclusion is that relative thin lunar elastic lithospheres can support substantial loads through membrane stresses.

For loads that have been expressed in terms of spherical harmonics we have obtained analytical expressions for the degree of compensation as a function of the degree n of the load. This dependence is shown in Figure 1 for various thicknesses of the lunar elastic lithosphere. Results are given for topographic loads (a) and non-topographic loads (b). The analysis includes both membrane and bending stresses. Also shown in Figure 1 are the results (dashed lines) for bending stresses only. It is seen that membrane stresses dominate for topographic loads and are important for low degrees for non-topographic loads. This analysis can also be applied to the preservation of a fossil rotational flattening of the moon.

Membrane stresses are also important in the support of topographic loads on Mars. They can explain the partial support of the load of the Tharsis uplift.

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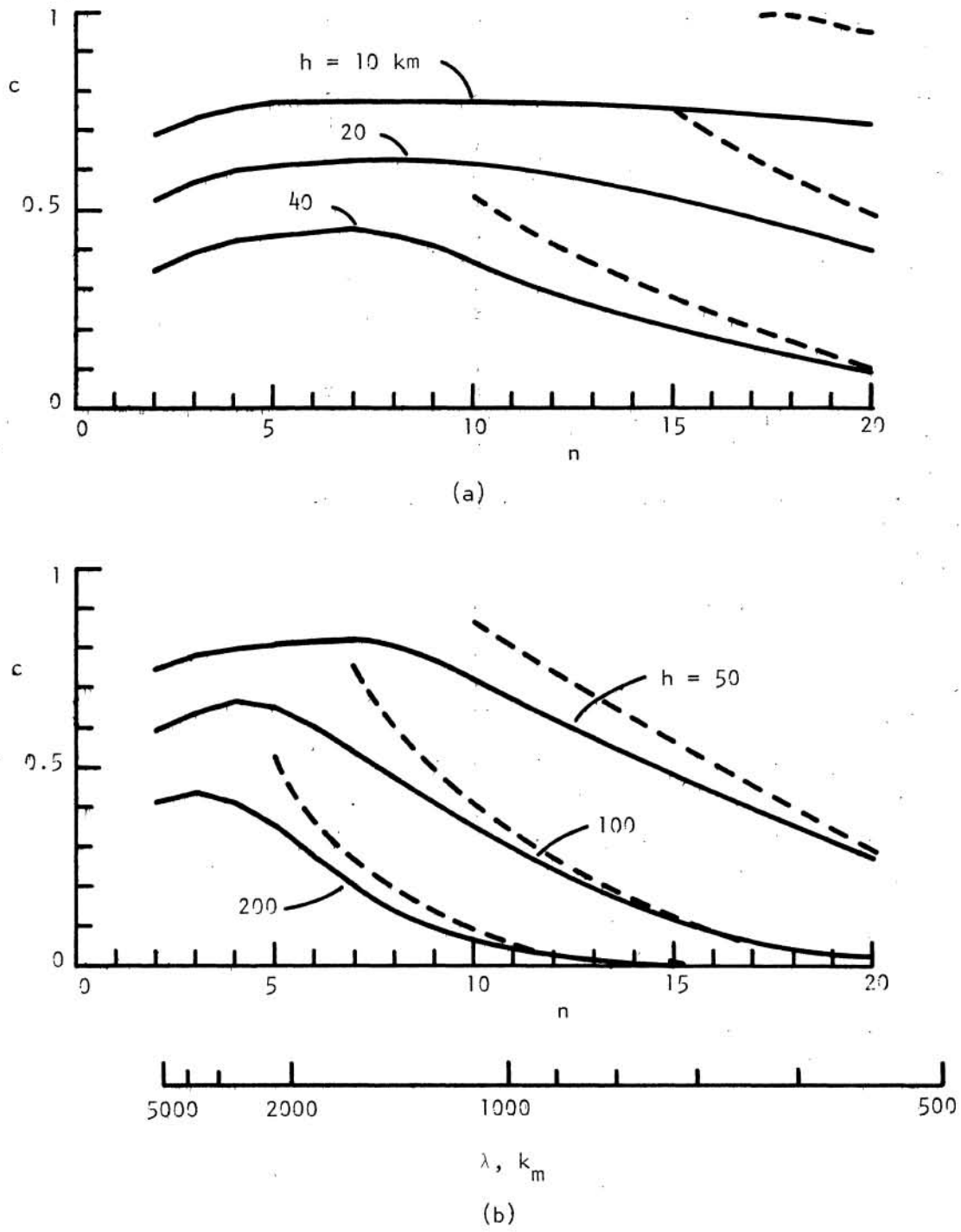

Figure 1. Degree of compensation c as a function of the order n of the load for several thicknesses of the elastic plate. (a) Lunar topographic loads. (b) Lunar non-topographic loads. Solid lines include both membrane and bending stress; dashed lines only bending stresses.

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