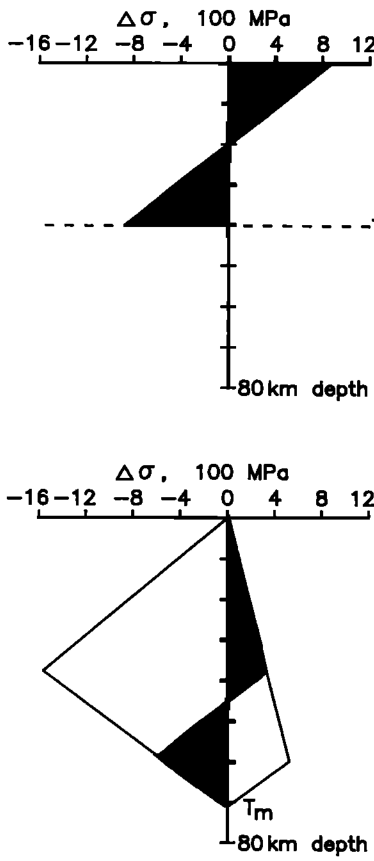

Fig. 4. Stress difference versus depth in a cross section of flexed lithosphere for two models [after *McNutt*, 1984]. The stress difference is between the vertical principal stress and the horizontal principal stress of greatest absolute magnitude; a positive (negative) stress difference denotes horizontal extension (compression). (Top) Elastic plate model. The stress difference varies linearly with depth and has extrema at the surface and at the base of the plate at depth $z = T_e$. (Bottom) Elastic-plastic plate model with the same bending moment (proportional to the solid area) and curvature (proportional to the slope of the stress difference versus depth in the central portion of the plate) as in the elastic model. The stress difference is limited by frictional strength in the upper plate and ductile strength in the lower plate. Ductile strength, approximated by a linear function of depth, depends on the thermal gradient, strain rate, and composition. The base of the mechanical lithosphere is at $z = T_m$. The nominal model shown corresponds to the ductile strength given by the flow law for olivine, a strain rate of 10^{-19} s^{-1}, and a mean thermal gradient of 10 K km^{-1}.

sphere thickness exceeds the crustal thickness, the ductile strength is taken to be limited by the creep strength of olivine [*Goetze*, 1978; *Evans and Goetze*, 1979], with the linear slope of the strength envelope taken from the high-stress (Peierls) form of the flow law. If the mechanical lithosphere thickness is comparable to or less than the crustal thickness, then the ductile strength is taken to be that of diabase [*Caristan*, 1982], with the linear slope given by the tangent to the nonlinear strength envelope at a stress difference of 200 MPa.

Relationships among effective elastic lithosphere thickness T_e, mechanical lithosphere thickness T_m, thermal gradient dT/dz, and plate curvature K are illustrated in Figures 5 and 6 for ductile portions of the strength envelope appropriate to mantle and crustal material, respectively. As demonstrated by *McNutt* [1984] with similar curves for terres-

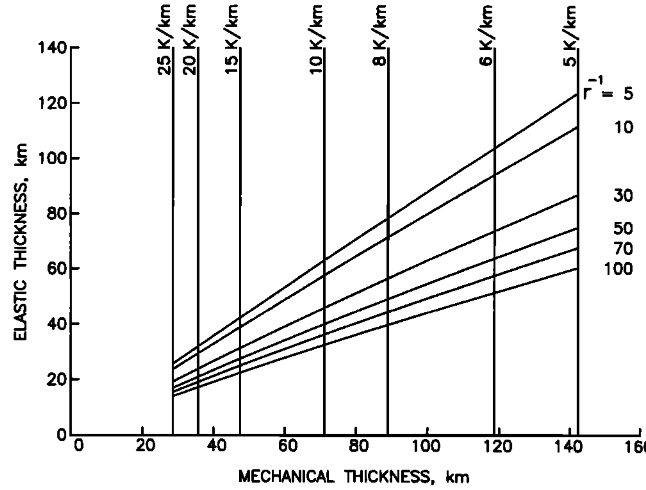

Fig. 5. Chart for converting effective elastic plate thickness T_e to the depth T_m to the base of the mechanical lithosphere as a function of flexural curvature r^{-1} (in units of 10^{-8} m^{-1}) [after *McNutt*, 1984]. The ductile strength is taken to be that of olivine [*Goetze*, 1978] at a strain rate of 10^{-19} s^{-1}. The lithospheric thermal gradient, taken to be uniform, is shown at representative values for T_m.

trial oceanic lithosphere, T_m can exceed T_e by a factor of 2 or more for large values of plate curvature, i.e., when the bending stress predicted by the uniform elastic plate models exceeds the strength envelope over significant depth intervals at the top and bottom of the mechanical lithosphere.

Sources of Uncertainty

The uncertainties introduced by several of the simplifying assumptions made to obtain Figures 5 and 6 are worthy of note. In flexural problems it is generally the flexural rigidity D that is the most robust parameter determined. Estimation of T_e from D requires knowledge of the elastic parameters E and ν; for a layered plate these parameters are thickness-averaged values [*Zhang and Wong*, 1988]. Although the

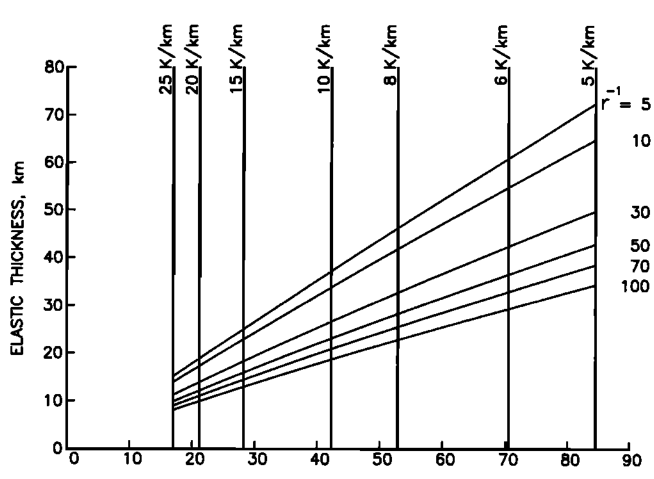

Fig. 6. Chart for converting effective elastic plate thickness T_e to the depth T_m to the base of the mechanical lithosphere as a function of flexural curvature r^{-1} (in units of 10^{-8} m^{-1}) if ductile strength is taken to be that of diabase [*Caristan*, 1982] at a strain rate of 10^{-19} s^{-1}.