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article

Estimates of the Effective Elastic Thickness (T_e): Any signs of agreement?

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There is little controversy about the value of T_e estimated from oceanic measurements of gravity and bathymetry. Its value is often obtained from the relationship between the free air gravity and bathymetry in the spectral domain. Estimates of T_e from those few regions where there is good 2D bathymetric coverage give values which vary from 2-4 km for spreading ridges to $\sim$ 20 km for old lithosphere like that beneath Hawaii. There is a general belief that the elastic thickness is controlled by the depth of an isotherm whose value is $\sim 450°$C, and that $T_e < T_s$, the seismogenic thickness, which closely follows the $600°$C isotherm. In contrast, there is no agreement between different estimates of T_e from continents, most of which are based on Forsyth's method using the coherence between Bouguer gravity and topography. In regions of rough topography his approach gives estimates of T_e that are similar to, though generally about double, those obtained from the free air gravity using the same approach as in the oceans. However, in regions with little topography, which includes most shields, the ratio between the two estimates often exceeds a factor of 5, with estimates of T_e from Forsyth's method often exceeding 100 km, corresponding to a limiting isotherm of $1000°$C or more. Laboratory experiments at such temperatures show that elastic stresses are relaxed in hours. This problem has generated a long running controversy. It is straightforward to show that estimates of T_e from Bouguer gravity depend only on the ratio of the power spectra of free air gravity to topography when the two are incoherent (M^{c}Kenzie, 2015), and are independent of the actual value of T_e. In many shield regions the topography is indeed incoherent with the topography. No valid estimates of T_e can then be obtained. However, it is nonetheless often possible to use the spectral ratio to estimate an upper bound on the value of T_e, which is generally < 30 km. Accurate maps of topography and gravity are now available from satellite measurements for most continents. If estimates of T_e are restricted to those regions with rough topography, where the coherence between the free air gravity and the topography exceeds 0.3, and are obtained using the same approach as is used in the oceans, all estimates are less than 30 km (M^{c}Kenzie et al. 2015). Furthermore, as in the oceans, $T_e < T_s$ everywhere, where T_s is determined from the depths of the deepest continental earthquakes. Though the values of T_e from shields show considerable variation, they do not correlate with the lithospheric thicknesses, probably because the thermal structure of the crust, like the surface heat flow, is controlled more by variations in crustal radioactivity than by lithospheric thickness.

M^{c}Kenzie D., Yi W. and Rummel R. 2015 Estimates of T_e for Continental Regions using GOCE gravity. *Earth Planet. Sci. Lett.* **428** 92-107.doi:10.1016/j.epsl.2015.12.010

M^{c}Kenzie D. 2015 A note on estimating T_e from Bouguer coherence. *Int. J. Geomath.* doi:10.1007_s13137-015-0078-4.