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The isostatic gravity anomaly: useful or misleading?

Jon Kirby
Curtin University, Earth & Planetary Sciences, Australia (j.kirby@curtin.edu.au)

Isostatic gravity anomalies are alleged to provide a measure of the Earth's gravity field free from the gravitational attractions of the topography and its isostatic compensation, most commonly represented by a variation in the depth of a compensating density contrast, for example the Moho. They are used by both geodesists and geophysicists alike, though often for different purposes. However, the majority of studies that employ the isostatic anomaly ignore the effects of the flexural rigidity of the lithosphere, most often represented as an effective elastic thickness (Te), and assume only surface loading of a plate with zero elastic thickness. The consequences of such an omission are studied here. It is shown that this assumption of purely local isostatic compensation can result in very large isostatic anomalies which may be misinterpreted as indicative of crustal density anomalies. Rather than using the standard deviation of derived isostatic anomalies to ascertain the best-fitting isostatic model, their full power spectra should be analysed. Furthermore, the effect of subsurface loading on the lithosphere must be incorporated into models, as these loads play a vital, and most often overlooked, role in the isostatic process. Failure to account for flexural rigidity and subsurface loading will result in over- or underestimates of both inverted Moho depths and dynamic topography amplitude, and underestimates of the size of topographic load that can be supported by the plate without flexure. An example of the latter is shown over Europe. It is also shown here that the common assumption of isostatic anomalies being smooth and thus suited for interpolation is misplaced. Again, an incorrect choice of isostatic model and its parameters can give rise to very rough anomalies. Given these findings, one must question the utility of isostatic anomalies.