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Gravity, dynamic topography and mantle flow

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Growing evidence from a variety of geologic indicators suggests that a significant portion of the topography of southern Africa is maintained convectively by viscous stresses in the sublithospheric mantle. However, while free-air gravity anomalies are sensitive to dynamically supported topography, there are only small free-air gravity anomalies and even smaller isostatic gravity anomalies (<10 mGal) associated with the long-wavelength topography of southern Africa. This observation has been used to suggest that most of the topography is in isostatic equilibrium, with convective viscous stresses accounting for no more than 200 metres of elevation.

Here we show that the apparent paradox is resolved by the well-established formalism of global, self-gravitating, viscously stratified Earth models. The models predict a complex relation between dynamic topography, mass and gravity anomalies that is not summarized by a constant admittance, i.e., ratio of surface deflections and gravity anomalies, which one infers from analytic flow solutions formulated in a half space. Our results suggest that sizable dynamic topography may exist without a corresponding gravity signal and that constant valued admittance studies provide us with lower bounds on dynamic topography.