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Estimates of the topographic uplift of the Southern African Plateau from the African Superswell through petrologically-consistent thermo-chemical modelling of the geoid, SHF, Rayleigh and Love dispersion curves and MT data

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The deep mantle African Superswell is thought to cause up to 500 m of the uplift of the Southern African Plateau. We investigate this phenomenon through stochastic thermo-chemical inversion modelling of the geoid, surface heat flow, Rayleigh and Love dispersion curves and MT data, in a manner that is fully petrologically-consistent. We invert for a three layer crustal velocity, density and thermal structure, but assume the resistivity layering (based on prior inversion of the MT data alone). Inversions are performed using an improved Delayed Rejection and Adaptive Metropolis (DRAM) type Markov chain Monte Carlo (MCMC) algorithm.

We demonstrate that a single layer lithosphere can fit most of the data, but not the MT responses. We further demonstrate that modelling the seismic data alone, without the constraint of requiring reasonable oxide chemistry or of fitting the geoid, permits wildly acceptable elevations and with very poorly defined lithosphere-asthenosphere boundary (LAB).

We parameterise the lithosphere into three layers, and bound the permitted oxide chemistry of each layer consistent with known chemical layering. We find acceptable models, from 5 million tested in each case, that fit all responses and yield a posteriori elevation distributions centred on 900-950 m, suggesting dynamic support from the lower mantle of some 400 m.