The impact of body forces on Archaean orogenic processes

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In the Archaean, the combination of warmer continental geotherm with a lighter subcontinental lithospheric mantle suggests that gravitational forces played a more significant role in continental lithospheric deformation. To test this hypothesis, we compare the evolution of the deformation and the regional state of stress in "Archaean-like" and "Phanaerozoic-like" lithospheres submitted to the same boundary conditions in a triaxial stress-field with imposed convergence in one direction.

For plausible physical parameters, thickening of normal to cold Phanaerozoic lithospheres produces relatively weak buoyancy forces either extensional or compressional. In contrast, for Archaean continental lithospheres, or for anomalously warm Phanaerozoic lithospheres, lateral gravitationally driven flow prevents significant thickening. This conclusion is broadly consistent with: (1) the relative homogeneity of the erosional level now exposed at the surface of Archaean cratons, (2) the sub-aerial conditions that prevailed during the emplacement of up to 20 km of greenstone cover, (3) the relatively rare occurrence in the Archaean record of voluminous detrital sediments, (4) the near absence of significant tectonic, metamorphic and magmatic age gradients across Archaean cratons, (5) the relative homogeneity of strain across large areas, and (6) the ubiquitous presence of crustal-scale strike slip faults in many Late Archaean cratons.