

Modeling of craton stability using a viscoelastic rheology

M. Beuchert, Y. Podladchikov, L. Ruepke & N. Simon

Physics of Geological Processes, University of Oslo, Norway

marcus.beuchert@fys.uio.no / Phone: +47-2285-6051

Archean cratons belong to the most remarkable features of our planet since they represent continental lithosphere that has avoided continental recycling for several billion years. Dating of inclusions in diamonds and thermobarometric measurements on xenoliths from kimberlites indicate that Archean cratons and their more than 200km thick lithospheric keels have remained cold and stable ever since their formation. Numerical modeling of craton stability has yet failed to reproduce this observed stability for billions of years. Using a two-dimensional FEM model, we show that high viscosity contrasts between the convecting upper mantle and the cratonic lithosphere are fully sufficient to account for the long-term stability of cratonic keels. We know from laboratory experiments that for mantle rocks at temperatures as in the cratonic keel, these viscosity contrasts are very high indeed; thus, one should use high viscosity contrasts in modeling of convecting mantle-lithosphere interaction. Furthermore, we suggest that the application of a viscoelastic rheology for the mantle helps to avoid the need to use intractably high viscosity contrasts, a problem modelers are commonly confronted with when using a viscous rheology. With a viscoelastic rheology, there is a transition from viscous to elastic behaviour above a certain threshold of viscosity contrast, resulting in stability of the cratonic keels. This approach is consistent with the viscoelastic nature of rocks.