Using geodynamic inverse modelling to constrain the rheology of the lithosphere

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The rheology of the lithosphere is one of the largest unknowns hampering our understanding of the dynamics of geological processes. As laboratory experiments have quite large uncertainties, particularly when extrapolated to geological conditions it is important to have an independent method to constrain the rheology of the lithosphere. Here we make use of the fact that on many places on Earth we now have quite a bit of knowledge on the deep geophysical structure of the lithosphere. We use that to construct geometric models of the lithosphere which we feed into a geodynamic forward models. Geophysical predictions computed from the forward models are compared with geophysical data. By framing this in a Bayesian inverse modelling framework we can derive optimal theological parameters, with uncertainty bounds, which are consistent with geophysical data. An application of this approach to the India-Asia collision zone unambiguous shows that a low viscosity mantle lithosphere, as proposed by some, is inconsistent with GPS, gravity and topography data. The inversion also shows that there is not one end member model that fits the data, but instead about 3 that have a nearly equal fit. As the lithospheric stress state of the each of this models is quite different, the simulations make testable predictions. Another clear result of the models is that the activation volume of the asthenosphere is towards the high end of experimentally determined values. We will also show first preliminary 3D models for the Alps.