Is it possible to constrain a realistic viscosity structure for the crust?

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Several studies on postseismic relaxation have been published so far, constraining the crustal viscosity structure of seismically active areas. The proposed crustal stratification is usually represented by an elastic upper crust underlain by one or two viscous layers representing the lower crust, and the preferred viscosity values are mostly obtained by minimizing the difference between the observed postseismic motions at a number of geodetic stations and the results from analytical or numerical relaxation models. From studies of rock mechanics, we know that a large gradient in viscosity has to be expected through the crust, mainly controlled by the rapid increase of temperature with depth. Therefore, we challenge the usual choice of representing the crust as composed by very few layers with homogeneous viscosity. Though aware that strong practical limitations in the description of an accurate viscosity layering for the crust are coming from the quality and quantity of the available geodetic data, we explore the theoretical adequacy of modelling thick homogeneous layers. By means of synthetic experiments with a semi-analytical viscoelastic relaxation model, we show how, for a given earthquake, the averaged viscosity values obtained for thick lower crustal layers are dependent on both the location of the geodetic stations and on the observation time window. We argue that the apparent effect of a viscosity gradient can be comparable to the effect of a transient rheology. We also propose a way to resolve a finer crustal layering, where the possibility of success is directly dependent on the availability of accurate and dense geodetic measurements.