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An estimation of viscosities based on postseismic deformation of the İzmit earthquake

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Intensive GPS monitoring after the İzmit earthquake provide a good chance to understand the postseismic behavior of a strike-slip fault and the rheology below the brittle upper crust. We analysis two datasets, the GPS measurement at 35 sites in the first 300 days after the İzmit earthquake and the velocity measurement between 2003 and 2005. The investigation about the postseismic deformation involves two aspects, viscoelastic relaxation of the lower crust and upper mantle, aseismic slip on the coseismic rupture plane in elastic media based on forward and inversion method respectively. The comparison of the two sides would provide some clue about the postseismic behavior on the strike-slip fault. Moreover, we suppose that the postseismic deformation after the aseismic slip process could elucidate the rheological property in the region.

Starting with a simple rheological model, E-M-M, referring to the elastic upper crust, the Maxwell lower crust and upper mantle, we calculate the best-fit viscosity of the observed displacements in different time periods. On the other hand, the surface deformation is inverted on the extended rupture plane down to the lower crust till the depth of 35 km. The results show that the first 300 days after the İzmit earthquake were dominated by aseismic slip on the fault plane of the elastic layer; whereas the displacement of far sites ($>$34 km away from the fault), especially after the first 100 days fits better to the viscoelastic model. With a dominant velocity of $\sim$5 mm/y after removing the secular component, the postseismic deformation was significant even 3 years after the İzmit earthquake, being better explained by the viscoelastic flow. In a next step, a more realistic rheological model, E-SLS-M model, which refers to the elastic upper crust, the Standard Linear Solid (SLS) lower crust and Maxwell upper mantle is built

based on the velocity measurements of 2003-2005 and the 'far' field measurements of 100-300 days after the İzmit earthquake. The viscosity of the Maxwell material below the crust is set to 7×10^{19}Pa·s according to the estimation from the E-M-M model based on the velocity of 2003-2005. The estimation displays that the transient viscosity of the SLS element is $\sim2\times10^{18}$Pa·s and the transient shear modulus is about half of the elastic one. The first $\sim$2 month is almost fully controlled by aseismic slip. With time and increasing distance from the fault, the contribution of viscoelastic relaxation increases. The explanation portion for viscoelastic relaxation of the refined model on the far sites about 60 km away from the fault is $\sim$0.2 larger than that on the near sites (less then 20 km).