Satellite gravity data of the regional rheological structure of the lithosphere in the vicinity of Sumatra is used as evidence to enable a better understanding of the regional geodynamic environment. The data is interpreted using the theory of post-seismic viscoelastic relaxation. Co- and post-seismic changes in the gravity field resulting from the 2004 Mw9.3 Sumatra earthquake were calculated from Gravity Recovery and Climate Experiment (GRACE) satellite data. A spatial Gaussian filter, 500 km wide, was used in the calculation. The results indicate that there were significant co-seismic jumps in both uplifted and subducted regions. The magnitude of the jump in the subducted zone was $\sim 9 \times 10^{-8}$ m/s$^2$, more significant than the $\sim 2 \times 10^{-8}$ m/s$^2$ jump observed in the uplifted zone. However, a positive gravity change occurred in the uplifted zone very soon after the earthquake. The rheological structure of the lithosphere has a great effect on deformation and its determination is a fundamental part of developing reliable numerical simulations in geodynamics. Based on the temporally-variable gravity field observed by GRACE, the viscous lithospheric structure of the Sumatra area is investigated with a self-gravitating, half space, viscoelastic earth model. The estimated viscosity is of the order of $1.0 \times 10^{18}$ Pa·s and there are differences in the rheological parameters on the two sides of the fault. The factors that affect the viscosity are discussed in connection with the tectonic structure of the Sumatra area.

This work is supported by the National Key Technologies Research & Development Program of China (Grant No. 2008BAC35B05).