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Finite-element models on spatiotemporal variations in the slip rates of active faults caused by postglacial unloading and rebound

T. Karow, A. Hampel

Institut für Geologie, Mineralogie und Geophysik, Ruhr-Universität Bochum, Universitätstr. 150, 44801 Bochum, Germany

Paleoseismologic data show that active faults in different tectonic settings experienced variations in their slip rate after the last glacial period. Examples include the Pärvie and Lansjärv reverse faults in northern Scandinavia (Lagerbäck, 1992; Mörner, 2005), the Wasatch and Teton normal faults in the Basin and Range Province (Byrd et al., 1994; Friedrich et al., 2003) and the Dead Sea Transform fault (Marco et al., 1996). Here we use three-dimensional finite-element models to evaluate the response of individual faults to glacial loading and postglacial unloading. The models consist of a lithosphere divided into an elastic upper crust, which contains the fault, a viscoelastic lower crust and a viscoelastic lithospheric mantle. Gravity is included in the models. To account for isostasy, a lithostatic pressure and an elastic foundation are applied to the bottom of the model, which is free to move in the vertical direction. Dashpots at the base of the model simulate the viscous behaviour of the asthenosphere. By applying velocity boundary conditions, the model is deformed such that the fault develops as thrust, normal or strike slip fault in different experiments. Preliminary results show that climate-controlled changes in the volumes of ice and water bodies on Earth's surface considerably alter the state of stress in the crust. These stress changes are large enough to affect the slip rate of an active fault. In general, faulting is suppressed in presence of the load and accelerated during unloading. Other factors controlling the response of the fault include the magnitude of the load and the viscosities of the lower crust and lithospheric mantle.