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THE LITHOSPHERIC STRENGTH OF THE EASTERN ALPS: NFERENCES FROM NUMERICAL PREDICTIONS

Ernst Willingshofer, Fred Beekman & Sierd Cloetingh

The present-day lithospheric strength of the Eastern Alps is calculated along the N-S running reflection seismic line "TRANSALP" and the W-E running refraction seismic line "ALP75". The results of the deep seismic surveys (e.g. SCARASCIA & CASSINIS, 1997; Transalp Working Groups) and the surface geology constrain the geometry of the modelled sections and allow setting up a lithospheric-scale rheological model. For both sections we calculated the thermal structure of the lithosphere through solving the heat transfer equation in two dimensions based on surface heat flow data (SACHSENHOFER, in press; DELLA VEDOVA et al., in press) and thermal boundary conditions. Finally, the yield strength along the TRANSALP and ALP75 sections was calculated based on failure (Byerlee's Law) and creep (power law creep) functions for which experimentally determined rock mechanics data (e.g. CARTER & TSENN, 1987) and constant strain rates are used. In agreement with the present-day stress regime strength calculations have been performed for compressional (TRANSALP) and extensional (ALP75) deformation.

Along the TRANSALP profile highest frictional strengths are predicted for the European upper and lower crust and the upper mantle underneath the Molasse Basin. Southward, lithospheric strength decreases and reaches a minimum in the area of the Tauern Window where frictional strength is restricted to the upper crust, only. South of the Periadriatic Line lithospheric strength increases again such that high frictional strengths are predicted for the Adriatic upper crust and the uppermost mantle. Unlike to the European crust hardly any strength is left within the Adriatic lower crust pointing to strong decoupling between the Adriatic upper crust and mantle. In W-E direction (ALP75 Line) frictional strength is concentrated within the top15 km of the upper crust in the Tauern Window area. Further to the east, underneath the Austroalpine Units, a distinct increase of strength within the lower crust and the upper mantle is related to a dramatic shallowing of the Moho as deduced from P-wave velocities. Towards the Styrian Basin lithospheric strength again decreases as a function of higher heat flow values in this area. Along the ALP75 section a strong crust-mantle decoupling is suggested.

The model predictions have been tested against the seismicity of the Eastern and the Southern Alps assuming that seismic activity is indicative for brittle deformation. The majority of the seismic events occurred along both lines (25 km wide zone on both sides of the lines) within the upper 15 kilometres of the crust. They correlate fairly well with the predicted depth extent of the brittle upper crust assuming a wet rheology and a constant strain rate of $10^{-14}s^{-1}$. Little seismic activity in the area of the European foreland supports the model predictions of a strong European plate. Within the Adriatic plate, movements along shear zones, within which strain rates are higher and, therefore, cause a downward shift of the brittle-ductile transition, may explain seismicity below the predicted cut-off depth for brittle deformation. Model predictions suggest that strain rates as high as $10^{-11}s^{-1}$ could account for the deeper earthquakes. Along the ALP75 Profile the upper part of the lower crust (ca. 20 km depth) retains some seismicity too, which is in better agreement with a dry rheology or higher strain rates.

The predicted lateral variations of lithospheric strength in N-S as well as W-E direction is in good agreement with the theory of extrusion models that promote the squeezing out of weak material from in-between more rigid blocks. Furthermore, lateral extrusion is supposed to be facilitated by a strong crust-mantle decoupling orthogonal to the convergence direction as also suggested by the model predictions. Seismicity and GPS data (e.g. GRENERCZY et al., 2000) suggest that this process is still active in the Eastern Alps.

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Authors' address:
Ernst Willingshofer (wile@geo.vu.nl), Fred Beekman, Sierd Cloetingh, Faculty of Earth Sciences, Vrije Universitei, De Boelelaan 1085, 1081 HV Amsterdam, The Netherlands