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Intraplate deformation and neotectonic controls on Europe's continental lithosphere (Stephan Mueller Medal Lecture)

S. Cloetingh

Netherlands Centre for Integrated Solid Earth Sciences, Vrije Universiteit Amsterdam, Faculty of Earth and Life Sciences, Netherlands

Until now, research on neotectonics and related topography development of intraplate regions has received little attention. We present results of numerical and analogue modeling for the quantification of rates of vertical motions, related river tectonics and land subsidence in a number of selected natural laboratories in Europe. From orogen through platform to continental margin, these natural laboratories include the Alps/Carpathians-Pannonian basin, the NW European platform, Iberia, and the northern Atlantic continental margin. A new lithospheric strength map for Europe's continental lithosphere displays pronounced lateral variations, primarily caused by spatial differences in the strength of the mantle lithosphere, whereas variations in the crustal strength appear to be much more modest. The variations in mantle lithospheric strength are primarily related to variations of the thermal structure of the lithosphere, reflecting upper mantle perturbations imaged by seismic tomography. Folding of the lithosphere appears to play an important role in the large scale neotectonic deformation of Europe's intraplate domain. The inferred wavelengths of most neotectonic lithosphere folds are consistent with the general relationship established between the wavelength of the lithospheric folds and thermotectonic age. Atypical folding is largely controlled by the interplay of thermal perturbations in the upper mantle and stress-induced deflection, such as observed in the Pannonian-Carpathians system. Analogue models incorporating the role of suture zones separating different crustal blocks, mid-crustal weak layers and significant mantle strength demonstrate that low amplitude lithospheric and crustal buckling is the primary response to shortening with a wavelength mainly controlled by the strong upper crust and/or lithospheric mantle. The resulting geometries display pop-ups and pop-downs above former suture zones. During shortening upward extrusion promotes exhumation of deep-seated levels and thrust-bounded deformation zones in front of indenters. The resulting strain-localisation is of key importance for basin architecture and sediment transport, with an interplay of lithospheric and surface processes operating at multiple scales.