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The Neotectonic crustal uplift and lithospheric softening in plate interiors caused by infiltration of mantle fluids into the lithosphere

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Large-scale crustal uplifts on the continents are commonly attributed to plate collision. Within the continents convergent boundaries now exist only in some regions, e.g., between the Eurasian and Indian plates. A predominant part of continental lithosphere refers to intraplate areas. Thus, the Precambrian crust where shortening terminated half a billion years ago or earlier covers about 70% of the continental areas. However, during the Pliocene and Pleistocene most of the Precambrian crust underwent the uplifts from 100-200 m to 1-2 km. They occurred over most of the African continent, in Greenland and East Siberia, and in many other regions. Neotectonic crustal uplift widely occurred on the Phanerozoic lithosphere. In most regions, e.g., in the Central and Northeastern Asia, the uplift by 1-2 km or more took place long after strong shortening of the crust in the Mesozoic and Paleozoic. It was accompanied by extension or compression of only a few per cent. In the absence of strong crustal thickening, the Neotectonic uplift in intraplate areas required a density decrease in the lithosphere which was caused by two main processes. The first one is expansion of previously metamorphosed dense mafic rocks within the crust due to a secondary metamorphism, diaphtoresis, under the temperature T = 350-400 °C. This mechanism is evidenced by a strong heterogeneity of the uplift in space. Thus in the Archean East Siberia in many places the uplift varies by 300-500 m in regions, only 20 km wide. Rock expansion from diaphtoresis required an inflow into the crust of large volumes of fluid from the mantle. The second process is a convective replacement by the asthenosphere of a denser mantle lithosphere whose viscosity was reduced by several orders of magnitude due to infiltration of fluids from the mantle. In many areas, e.g. in Central Asia and western North America this gave rise to a rise of the top of the asthenospheric layer by $\sim$100 km. Over most of the continental areas, as in East Siberia, the Neotectonic uplift occurred far from large mantle plumes and was associated with no or only weak magmatism. This shows that this uplift and the ascent of the plumes are quite different phenomena. The large Pliocene to Pleistocene crustal uplifts represent the most powerful tectonic process on the continents. They indicate large-scale quasi-synchronic supply of the mantle fluid to their lithosphere. In a presence of thin films of fluid at grain boundaries, the pressure solution mechanism of creep became dominant which gave rise to strong softening of the lithospheric layer. As a result, in some regions, e.g., in Northeastern and Southern Asia large inelastic deformations of the lithosphere occurred in the Pliocene and Pleistocene. Strong softening of this layer is also evidenced by the formation of steep basement slopes in many sedimentary basins on the Eurasian continent.