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Strong weakening of the lithospheric layer as a prerequisite for the formation of mobile belts

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Over most of continental areas the lithospheric layer has a high strength which allows it to drift for thousands of kilometres without significant horizontal deformations. At certain epochs rapid shortening or stretching of the lithosphere, however, occurred in some regions which indicates its temporary weakening. An important parameter characterising lithospheric strength is its effective elastic thickness Te estimated from the width L of lithospheric flexure under surface or sub-surface loads (Burov, Diament, JGR, 1995, 100, 3905-3927). A strong decrease in L is observed near to some convergent plate boundaries. This indicate lithospheric weakening which is commonly attributed to plate boundary processes. However, steep basement slopes of the crystalline basement, 10-50 km wide and 3-10 high, also exist in many intraplate basins which indicates a decrease in Te to 3-10 km. Such slopes are observed in the North Chukchi, Kara Sea, North Caspian and South Caspian basins, in the Transcaspian area and in many other regions. The slopes were formed at the epochs of strong acceleration of crustal subsidence which in many basins occurred without intense stretching and produced deep-water basins on continental shelves. In the absence of large isostatic anomalies above deep basins this indicates that rapid subsidence was caused by contraction of crustal rocks from metamorphism catalyzed by infiltration of mantle fluids. In a presence of thin films of fluids at the grain boundaries, pressure solution creep reduces drastically the viscosity of the lithospheric layer. After lithospheric weakening, long basins can be intensely shortened or stretched with the formation of fold belts and rifted terrains. Thus in the Alpine and Uralian belts strong shortening occurred only in those basins on continental crust which underwent rapid subsidence of a large magnitude.Intense crustal subsidence in Baikal Basin was accompanied by the formation of both steep basement slopes and large normal faults. Isometric basins such as the North Caspian Basin usually survived after rapid subsidence and lithospheric weakening thus preserving numerous steep basement slopes formed during the subsidence.

During the past several million years numerous mountain ranges, plateaus and other positive topographic features were formed on the continents after a period of relative stability $\sim$100 Ma long. Pronounced asthenospheric upwellings are observed under many of these regions, e.g., beneath the Central Asia and Western North America. This indicates recent convective replacement by the asthenosphere of subcrustal lithosphere which became weakened by infiltration of mantle fluids. In many regions mantle fluids infiltrated the crustal layer. This gave rise to a superimposed low-grade metamorphism (diaphthoresis) with the formation of hydrous minerals, rock expansion and the crustal uplift. Large lateral nonuniformity of the uplift in some regions, e.g., in the Archean East Siberia and Mesozoic Verkhoyansk Range indicates the appearance of a low-viscosity layer in their crust.