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Crustal uplift of the Precambrian cratons due to metamorphism in crustal rocks under infiltration of mantle fluids

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Precambrian cratons cover about 70% of the total area of the continents. During the last several million years cratonic areas underwent rapid uplift, from 100-200 m in East Europe to 1000-1500 m Southern Africa. Shortening of the Precambrian crust terminated half a billion years ago or earlier and this popular mechanism cannot be applied to its recent uplift. Large thickness of cratonic mantle lithosphere, 100-200 km in most regions, together with its low density precludes delamination of this layer and magmatic underplating as possible causes of recent uplift.

It cannot be precluded that in some cratonic regions recent uplift occurred due to delamination of the lower part of mantle lithosphere with the density increased by metasomatism. Even a small uplift of $\geq$ 100-200 m would require delamination of a thick layer of mantle lithosphere. As a result a temperature drop of $>$ 200 C would arise at the base of the lithosphere producing a shear wave velocities drop of $> 2\%$. According to the seismic tomography data such a drop in V_S is observed only in some regions with the Precambrian lithosphere, e.g., in Northeastern Africa.

Spatial distribution of the Precambrian cratons is quite different from that predicted by the main models of dynamic topography in the mantle. Moreover, many uplifted blocks are bounded by steep slopes hundreds of meters to one kilometer high and only tens of kilometers wide. Such slopes could not have been formed by bending of thick cratonic lithosphere under the forces acting from below. Their recent formation indicates rock expansion within the crust at shallow depth comparable with the slope width.

Rocks formed at the pressure P $\sim$ 0.5-1.0 GPa are widespread on the Precambrian cratons. This indicates that during their lifetime a layer of rocks $\sim$ 15-30 km thick has been removed from the crustal surface by denudation. As a result rocks which were initially located in the lower crust emerged to the middle or upper crust. Due to metamorphic reactions under the new P-T conditions the density of rocks would become considerably lower. The analysis of phase diagrams of typical crustal rocks shows that the associated expansion of rocks could produce the crustal uplift up to 2000 m. However no metamorphism occurred in rocks as long as they remained dry. Rapid uplift of the Precambrian cratons during the last several million years can indicate infiltration into the crust of fluids from the mantle. The volume of fluid infiltrated into the crust should be comparable with the cumulate volume of the Neotectonic crustal uplift. Under such circumstances it can be expected that in some Precambrian regions a fluid rich layer now exists within the crust. It should be characterized by a high electrical conductivity and decreased S-wave velocities.