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Model of the Arctic evolution since the Cretaceous to present, based on upper mantle convection linked with Pacific lithosphere subduction

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The present paper comprises a model of Arctic basin evolution since early-mid Cretaceous to present. The model is based on the mechanism of upper mantle substance circulation beneath the Arctic lithosphere linked with Pacific lithosphere subduction. Seismic tomography data obtained for the Pacific-Eurasia-Arctic joint area indicate that Pacific lithosphere slab sinking to the mantle in subduction zone transforms into the horizontal layer upon reaching the upper mantle foot, this layer extending for two or more thousands km beneath the Eurasian continent. This pattern of seismic tomography indicates the presence of a horizontal convective cell where a flow of substance moving along the upper mantle foot from a subduction zone into the continent is compensated by a return flow moving along the lithosphere foot towards the subduction zone. The return mantle flow makes continental lithosphere extension, giving rise to processes of rifting, magmatism and spreading. The convective cell being continuously supplied with new substance which is transported through the subduction zone it is sure to expand horizontally. The above cell expansion occurs first, due to ocean ward movement of subduction zone (roll back) and secondly, due to the cell front propagation into the continent. The given model allows to understand main features for the Arctic evolution since early-mid Cretaceous to present. Numerous seismic profiling data obtained for shelf and deep water sedimentary basins in the Arctic Ocean as well as on land geological investigation reveal that since Aptian up to present the Arctic region has been characterized by sublatitudinal lithosphere extension. This extension is explained by the effect the return mantle flow related to the subduction of the Northern part of the Pacific plate acts on the Arctic lithosphere foot. The model shows the phenomenon of Arctic plume to be caused by the convective cell uprising flow. In fact lower horizontal flow of convective cell moving from the subduction towards the Barents-Kara margin carries of subsiding ocean lithosphere hydrated substance that subsequently gets into the upwelling zone. Uplift and decompression of hydrated rocks results in conditions favouring in intensive melting and magmatism. The above accounts for the existence of magmatic High Arctic Large Igneous Province. Extension stresses result in the “first cretaceous block stripe” represented by Alfa and Mendeleev ridges breaking away from Barents-Kara margin, thinning continental crust area being created in their rear to form Makarov and Podvodnikov basins. Rift extension of Makarov and Podvodnikov basins took place during the period 110-60 Ma. During this period the cell extended horizontally both due to the Pacific ward roll back of the subduction zone, and cell front propagation into the Barents sea margin. The latter eventually caused the breaking of the “second Cenozoic tectonic block stripe” forming Lomonosov ridge away from Barents sea margin. During the Cenozoic the process of Lomonosov ridge moving aside was accompanied by the formation of Eurasian basin in its rear.