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Discipline
Geophysics

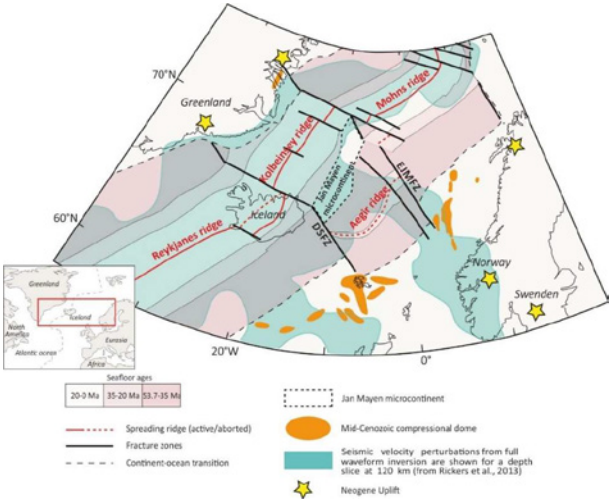
Keywords
Geodynamics, Iceland Mantle Plume, Numerical Modelling, Plume–Lithosphere Interaction, Thermochronology

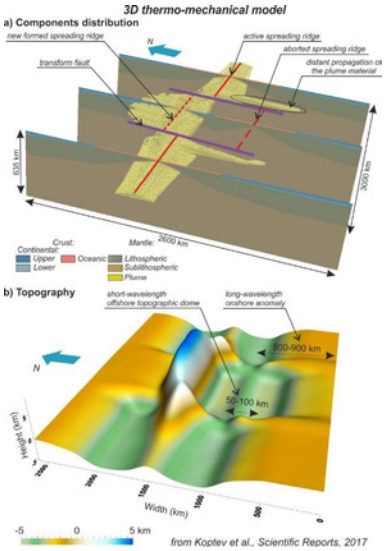
Long-distance impact of Iceland mantle plume on Scandinavian topography

Recent seismic tomography data reveal an enigmatic spatial distribution of mantle plume material in the Northern Atlantic: the Iceland plume extends not only parallel to the mid-oceanic ridge, but also perpendicular to it over great (~1000 km) distances in a south-eastward direction beneath the northern British Isles and the southern Scandinavia. Another important aspect of the North Atlantic system includes the presence of long-wavelength (hundreds of km) anomalies in onshore topography of Norway's rifted margin and short-wavelength offshore topographic domes with characteristic wavelengths of several tens of km.

A series of 3D thermo-mechanical experiments has been performed with the objective to examine the impact of the Iceland mantle plume on post-break-up evolution of the North Atlantic. The models show very fast (▸10 cm/year) south-eastward propagation of hot plume material along transform faults up to southern continental segments. The presence of mantle plume material underneath thinned lithosphere leads to formation of significant differential offshore topography and elevated onshore margin topography due to thermal weakening and ridge-push related compressional forcing. In contrast, the rifted margin at locations without mantle plume does not show considerable topography variations. Therefore, the overall patterns predicted by modelling provide a first-order explanation for long horizontal flows originating from the Iceland plume and significant differential topography at the Mid-Norway margin.

Further studies will be made in an attempt to combine performed large-scale thermo-mechanical modelling of plume-lithosphere interaction in the Northern Atlantic with a local-scale model of glacial-fluvial erosion. With this purpose, the coupled model of glacial, fluvial, and hillslope landscape evolution in Scandinavia will incorporate the variations in rates of tectonic rock-uplift derived from the 3D thermo-mechanical modelling.





Vita

After receiving his PhD in Geology from the Moscow State University Alexander joined the Institute of Earth Sciences of Paris (ISTEP) of the University of Pierre and Marie Curie (UPMC) and subsequently the Earth System Dynamics group at the University of Tübingen as a postdoctoral fellow. His research interests include numerical modeling of interactions between mantle plumes and continental lithosphere, subduction processes, as well as links between topography and tectonics.