Geophysical Research Abstracts
Vol. 19, EGU2017-2676, 2017
EGU General Assembly 2017

Across-strike and along-strike asymmetry as an intrinsic characteristic of plume-induced continental rifting: Insights from 3D numerical modeling

Alexander Koptev (1), Evgueni Burov (1), Taras Gerya (2), Laetitia Le Pourhiet (1), Sylvie Leroy (1), Eric Calais (3), and Laurent Jolivet (4)

(1) Sorbonne Universités, UPMC Univ Paris 06, CNRS, Institut des Sciences de la Terre de Paris (iSTeP), 4 place Jussieu 75005 Paris, France, (2) ETH-Zurich, Institute of Geophysics, Sonnegstrasse 5, 8092 Zurich, Switzerland, (3) Ecole Normale Supérieure, Dept. of Geosciences, PSL Research University, CNRS UMR 8538, Paris, France, (4) Univ d'Orléans, ISTO, UMR 7327, 45071 Orléans, France

We present a series of numerical experiments of ascending mantle plume interacting with a rheologically realistic continental lithosphere subjected to ultra-slow far-field extension. Our study focuses on the variations of plume-induced rifting style – mode of strain localization, deformation zone width, spatial location of resulting break-up and spreading axes – as a function of variations in thermo-rheological properties of the continental lithosphere.

Our results illustrate that the geometry of the plume-induced rifting/break-up pattern can be strongly variable and asymmetric even in the absence of inherited crustal/lithospheric heterogeneities. This asymmetry seems to be an intrinsic characteristic of plume-induced rifting/spreading process that develops spontaneously from initially symmetrical plume-lithosphere geometry.

Along-axis asymmetry is represented by non-uniform ascent of plume material along the future break-up center, which results in the development of separated magma chambers. This scenario involving faster localized uplift of the plume material at the distal point from the plume center can be compared with magmatic and tectonic evolution of the South Atlantic where seafloor spreading propagated northward up to the Tristan da Cunha hot-spot.

Across-strike segmentation is shown in our models by complex asymmetric systems characterized by various velocities of plume material uplift along different localized axes leading to contrasting rifting. The final position of the continental break-up zone(s) is likely to be offset with respect to the plume impingement and, consequently, does not necessarily coincide with the area of pre-rift uplift and magmatism.

Most of our 3D experiments, as well as other 3D experiments published the last 10 years, produce self-induced temporal and spatial (across-strike just like along-strike) break-up irregularities that were only produced in 2D using very strong mechanical heterogeneity. Without dismissing heterogeneities are present in the crust and the lithosphere, it is maybe time to re-evaluate how important they must be and to reconsider the assumed role of pre-existing lithospheric or sublithospheric structures in the dynamic processes associated with continental rifting.