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The Thermo-Mechanical Impact of Plume Arrival on Continental Break-Up

S. Brune (1), S. V. Sobolev (1), and A. A. Popov (2)

(1) GFZ-Potsdam, Geodynamic Modeling Group, Potsdam, Germany (brune@gfz-potsdam.de), (2) Institute of Geosciences, Johannes Gutenberg University, Mainz, Germany

A key factor for continental break-up is the arrival of a mantle plume at Earth's continental lithosphere. In the South Atlantic, the Central Atlantic, and the Norwegian-Greenland Sea, lithospheric rifting predates break-up by several 10 My or more. Interaction between a plume and the rifting lithosphere, however, marks the beginning of the continental break-up process. A mantle plume reduces lithospheric strength by multiple means: (i) lithosphere erosion from below, (ii) strong local temperature increase, (iii) melt generation and diking. Moreover, the extensional force is increased due to (iv) augmented thermal buoyancy and (v) dynamic uplift. However, the relative importance oft these processes is unclear.

In this study, we quantify the mechanical and thermal impact of a plume (i.e. lithosphere erosion, temperature increase, and thermal buoyancy) on continental break-up. We therefore apply the three-dimensional numerical code SLIM3D that features realistic elasto-visco-plastic rheology and a free surface. We model the thermo-mechanical response of a segment of Earth's lithosphere that is affected both by extension and plume arrival. This allows us to evaluate the plume's influence on the lithospheric strength and the overall force budget.