AGU FALL MEETING
San Francisco | 14 – 18 December 2015

T41D-2936: Impact of far-field stress distributions and thermo-rheological structure of continental lithosphere on mantle-lithosphere interactions.

Wednesday, 16 December 2015
17:00 - 17:15
Moscone South - 302

We implement fully-coupled high resolution 3D thermo-mechanical numerical models to investigate the impact of the laterally heterogeneous structure and rheological stratification of the continental lithosphere on the plume-activated rifting and continental break-up processes in presence of preexisting far-field tectonic stresses. In our experiments, “mantle plumes” represent short-lived diapiric upwellings that have no continuous feeding at depth. Such upwellings may be associated with “true” plumes but also with various instabilities in the convective mantle. Numerical models demonstrate strong dependence of crustal strain distributions and surface topography on the rheological composition of the lower crust and the initial thermal structure of the lithosphere. In contrast to the usual inferences from passive rifting models, distributed wide rifting takes place in case of cold (500 °C at Moho depth) initial isotherm and mafic composition of the lower crust, whereas hotter geotherms and weaker (wet quartzite) lower crustal rheology lead to strong localization of rifting. Moreover, it appears that the prerequisite of strongly anisotropic strain localization during plume-lithosphere interaction (linear rift structures instead of axisymmetric radial faulting) refers to simultaneous presence of a mantle upwelling and of (even extremely weak) directional stress field produced by far-field tectonic forces (i.e. ultra-slow far field extension at < 3 mm/y). Higher (than 1.5-3 mm/y) velocities of far-field extension lead to enlargement of the active fault zone for the same lapse of time. Yet, simultaneous rise of the lithospheric geotherm associated with active rifting has an opposite effect leading to the narrowing of the rift zone. Presence of heterogeneities (cratonic blocks) leads to splitting of the plume head onto initially nearly symmetrical parts, each of which flows towards beneath the craton borders. This craton-controlled distribution of plume material causes the crustal strain localization and uprise of plume material along the craton boundaries. Though there is a net tendency of more rapid transition to spreading in case of more intensive far-field forcing, the presence of «cratonic» blocks seemingly leads to acceleration of break-up processes.

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