The thermal evolution of the South Atlantic marginal basins

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Abstract

The South Atlantic conjugate margins result from continental rifting and break-up of Pangea. The Tristan Plume possibly interfered with the formation of the margins of the South Segment in the South Atlantic domain. In the current project, we investigate the thermal evolution of marginal basins from the continental rift initiation until the early spreading phase induced by large-scale tectonic processes. 2D thermo-mechanical numerical modelling techniques are used to explore the continental break-up with complex, model setups also including thermal anomalies. The thermal evolution of the various rift-to-spreading modes is finally used to compute heat flows at base of the sedimentary basin. The thermo-mechanical model results show that, depending on the initial location of a thermal anomaly (or plume) various modes of break-up develop, amongst which are 1) the classical ‘central’ or ‘plume-centred’ mode, where the break-up centre develops directly above the plume-impingement point, 2) a ‘distant’ mode, where the lithosphere breaks far away from the plume-impingement point operating in quasi-passive regime, 3) a ‘shifted’ type of break-up, where break-up occurs offset from the plume-impingement point, but where plume-material still reaches the break-up centre after migration along the base of the lithosphere. These results are then used as inputs to simulate in more detail the thermal evolution of conjugate margin basins with a 1D heat flow equation. Heat flow trends calculated for these break-up modes show that in absence of plume material at the spreading centre (so e.g. a ‘distant’ mode of break-up), heat flow rates are lower than when plume material does reach the spreading axis (e.g. ‘central’ or ‘shifted’ type of break-up). The models also show that dissimilar heat flow rates could have occurred between conjugate margins. For a basin that developed on the margin of a ‘shifted’ break-up mode where plume material migrates along the base of the lithosphere, heat flow values are generally higher than on its conjugate, where no plume material migrated along its base. The different heat transfer trends can directly be used as initial and boundary thermal conditions for basin modelling to investigate an impact of spatially and temporally varied heat flow on basin scale processes e.g. hydrocarbon maturation and generation.