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Rift segment interaction in the conjugate Santos/Campos-Namibe/Benguela system, South Atlantic, from integrated seismic observations, plate kinematic and numerical modelling

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The conjugate Santos/Campos-Namibe/Benguela margin system of the South Atlantic is the result of complex 3D interaction of two rift segments. Data acquired in the context of extensive hydrocarbon exploration efforts in the basins allow to study the first order evolution of lithosphere deformation, magmatism, microplate and basin infill dynamics across scales in an area of interacting rift segments. Utilising an extensive set of industry seismic, well and potential field data we can subdivide the evolution of the rift system into three key phases, linked to changes in the plate kinematics.

The South Atlantic rift was initiated in earliest Cretaceous time, prior to the arrival of the Tristan plume. During this first phase, deformation primarily localised in the western, proximal part of the Santos basin. In this early rift phase, the arrival of the Tristan plume resulted in the emplacement of the Parana-Etendeka large igneous province, significantly affecting the evolving rift architecture and infill, and leading to a phase of potentially magma-compensated thinning with extensive subaerial volcanism. Fault mapping and -activity age assignment based on seismic stratigraphy indicates continued eastward migration of deformation towards the Base Salt deposition time, documented by an extensive set of westward dipping normal faults. At around 125 Ma, changes in extension direction and velocities can be linked to an eastward jump of the deformation towards the African margin resulting in a second, transitional, phase and likely the formation of the so-called Jupiter step. During deposition of salt, rift segment linkage and structural re-organisation continued in the Jupiter step area with significantly less magmatism than observed in the earlier extension phase and a predominantely eastward-dipping structural grain. Subsequent hyperextension and highly asymmetric thinning in the last phase lead to a conjugate rifted margin system with a wide Santos and narrow Namibe margin before establishment of a seafloor spreading ridge between Africa and South America.

We supplement our observation-driven synthesis by means of 3D forward numerical modelling of lithosphere deformation using the code ASPECT. Exploiting a range of permissible geometrical and kinematic boundary conditions, we investigate 3D rift evolution scenarios, which address the effect of rift segment overlap and -orientation on microplate- and accommodation space formation.