Coupling crustal-scale rift architecture with passive margin salt tectonics: a geodynamic modelling approach

Leonardo Pichel¹, Ritske Huismans¹, Rob Gawthorpe¹, Jan Inge Faleide², and Thomas Theunissen¹

¹University of Bergen, Department of Earth Sciences, Bergen, Norway
²University of Oslo, Department of Geosciences, Oslo, Norway

Many rifted passive margins are associated with widespread and thick evaporite (i.e., salt) deposits, and pronounced syn-and post-rift salt tectonics. The majority and largest salt basins known-to-date formed during the latest stages of rifting, immediately prior to continental breakup. We use 2D thermo-mechanically coupled finite-element modelling of lithospheric extension to investigate the interplay between variable styles of rifted margin, syn-rift architecture, and consequences for the distribution of late syn-rift salt, and post-rift salt tectonics. We simulate the formation of salt basins in different types of continental margins: narrow, intermediate, wide, and ultra-wide margins. For each of these, we evaluate: 1) the interplay between rifting, post-rift sediment progradation, base-salt topography and margin scale salt tectonics, 2) the spatial and temporal distribution of salt-related structural domains, and 3) the contrasting styles of salt tectonics for different margin types. We show that narrow and intermediate margins form partially isolated salt basins in their proximal domain with limited translation and significant vertical diapirism. Their distal portions are associated with significant translation, development of updip listric normal faults and rollovers passing downdip to squeezed diapirs. Wide and ultra-wide margins form wide salt basins with a more subtle base-salt topography which result in significant basinward salt expulsion and overburden translation towards their distal domains. These margins are characterized by updip extensional and/or expulsion rollovers and downdip salt inflation, diapirism and shortening in the form of diapir squeezing, buckle-folding and development of allochthonous salt sheets. All margins present a distal salt nappe that varies in width for each margin type and forms as a consequence of syn-rift distal salt stretching and post-rift thrusting. These models are the first to integrate lithospheric extension with long-lived post-rift salt tectonics using a geodynamically self-consistent modelling approach where the geometries of the lithosphere and salt basins are not prescribed, allowing a natural evolution of syn and post-rift deformation. They also incorporate a more realistic style of post-rift progradation using a dynamically evolving profile and present unprecedented detail for salt, syn- and post-rift stratigraphy. The results can be directly compared to examples from various salt-bearing continental margins and provide an improved understanding on the kinematics and relative timing of rift and salt deformation, and on the controls and variability of salt tectonics for different margin types.