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Geodynamic modelling of salt tectonics and translation speed at rifted continental margins

Xuesong Ding[1], Zhichen Wang[2], Sascha Brune[3,4], Tim Dooley[1], Lorena Moscardelli[1], Derek Neuharth[3], Anne Glerum[3], Delphine Rouby[5], Naiara Fernandez[3], and Mike Hudec[1]
[1]Bureau of Economic Geology, University of Texas at Austin, Austin, United States of America
[2]Key Laboratory of Orogenic Belts and Crustal Evolution, School of Earth and Space Sciences, Peking University, Beijing, China
[3]Helmholtz Centre Potsdam-GFZ German Research Centre for Geosciences, Potsdam, Germany
[4]Institute of Geosciences, University of Potsdam, Potsdam-Golm, Germany
[5]Géosciences Environnement Toulouse (GET), Université de Toulouse, CNRS, IRD, UPS, CNES, Toulouse, France

Salt tectonics at rifted margins involve intricate interactions between weak, ductile evaporite layers and brittle sedimentary rocks. Fully coupled geodynamic and surface process modeling can provide new insights into the dynamic controls on salt tectonics. We adopt such a modeling tool (ASPECT + FastScape) to investigate the evolution of salt-detached systems on magma-poor rifted margins.

Firstly, we investigate the controls on the temporal changes in the seaward translation velocity of salt and overlying sediments and the impacts of salt translation on the deformation of salt and overburden. Our modeling results indicate that translation velocities of salt and overburden first quickly increase to a peak value, controlled by highly nonlinear salt rheology, then slowly drop as the salt layer thins and welds. Thicker salt deposits generate higher peak translation velocities. Moreover, rapid salt translation creates wide, low-amplitude rollovers in the upslope extensional domain, irregularly spaced collapsed diapirs in the midslope domain, and complex diapir structures in the downslope contractional domain. Slow translation, on the other hand, produces regularly spaced salt pillows and diapirs in all domains. Asymmetric minibasins in translational and compressional domains interact with adjacent diapirs, forming strongly upturned and overturned strata.

Secondly, we investigate the dominant controls on salt-detached systems at different stages of rifting. We test three scenarios in which salt deposition occurs at early (scenario 1), middle (scenario 2), and late (scenario 3) stage of rifting, respectively. In scenario 1, salt is subject to continued extension, is offset by basement faults, and is separated into disconnected subbasins. In scenarios 2 and 3, the initial salt basin is more extensive than in scenario 1. A large-scale shear

zone develops within the salt layer, assisting seaward translation of salt. Salt diapirs form preferentially on the slope and in deep water. We also find that submarine sediment transport efficiency strongly affects the final salt tectonic architecture. Our models show that less efficient marine sediment diffusion results in larger base-salt relief and hence promotes salt diapirism and minibasin formation.