Numerical modelling of the evolution of the salt diapiric internal structure

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Evaporate series are composed of a range of interbedded rock types such as carbonates (calcite, dolomite), sulphates (anhydrite, gypsum), and chlorides (rock salt, potassium and magnesium salt). The presence of evaporates particularly with thick salt layers within sedimentary basins significantly influences their tectonic evolution. This is due to unique properties of salt, which cause that salt buried under sediments becomes buoyant and migrates towards the surface promoting development of diapiric structures. The intensive complex deformation that operates on the layered evaporates sequence leads to the development of a complicated diapir internal architecture. Varying material properties such as viscosity and density of different rock types in the evaporate series contribute to the complexity of the formed structures.

We numerically investigate the initiation and evolution of tectonic structures within the salt diapirs comprising mechanically stratified evaporate series. We analyse the role of parameters such as mechanical properties of the layered evaporate series and the overburden rocks, the initial spatial arrangement of different rock types, the rate of sedimentation of the overburden rocks, and various deformation regimes. In the study, we focus on the relationship between the structures such as folds and boudinage structures that develop on a small-scale (corresponding to the outcrop scale in the salt mine galleries) and a large-scale (corresponding to the whole diapir scale). Additionally, the influence of the internal structure development on the evolution of the overall diapir shape is examined.

In the numerical model, we use non-linear viscous rheology for the evaporate series and the overburden. We solve an incompressible Stokes equation in the presence of the gravity using the finite element method solver MILAMIN [1]. The diapir evolution is simulated in two dimensions. The development of complex structures is analysed using the resolved interface method, since this is a suitable method to trace the evolving rock interfaces in high resolution and, thus, to accurately describe the evolution of the internal diapir structures.

[1] Dabrowski, M., Krotkiewski, M., and Schmid, D. W., 2008, MILAMIN: MATLAB-based finite element method solver for large problems. Geochemistry Geophysics Geosystems, vol. 9.