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Analysis of tectonic structure evolution in a multilayer evaporite sequence: a case study from the Kłodawa Salt Structure, Poland

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Evaporites are typically composed of various lithological varieties of halides, sulphates, and other salts. These rocks are generally characterized by low density and low viscosity, and their physical and mechanical properties may significantly vary. Intercalations of other rocks in the sequence, e.g. clay rocks, further influence rheological heterogeneity within the evaporite series. During deformation, this heterogeneity may lead to development of very complex tectonic structures, in particular in diapiric salt bodies. This study presents results of analysis of tectonic structure evolution in a multi-layered rock system, and it is motivated by natural deformational structures that were documented in the Kłodawa Salt Structure (KSS), central Poland. Here, spectacular, various scale fold structures occur within Younger Potash K-3 (potash complex of the third Zechstein cycle).

The analysis of tectonic structure evolution was carried out with use of numerical modelling. Own codes implemented in MATLAB, combined with the MILAMIN and MUTILS numerical packages were applied. To gain an understanding of structure development and rheological properties of rocks, a model consisting of layers of intercalating rock salt, carnallite, and kieserite was constructed. It was assumed that the layers are in gravitationally unstable arrangement. The study primarily focuses on the role of: 1) viscosity ratio, 2) density difference between the layers, 3) relative layer thickness, and 4) interface geometry. The results were compared with documented examples of tectonic structures from the KSS.

The resultant models showed variable resemblance to the natural examples. Depending on applied parameters, sets of geometrically differing tectonic structures were developed. The analysis and the models imply that a wide spectrum of rheological properties of rocks can be inferred based on numerical simulations. They provide hints to rheological properties of natural rocks during the deformation within the KSS.