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Constraining the temporal evolution of a deep hypersaline anoxic basin by 1D geochemical modelling

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Deep hypersaline anoxic basins (DHABs) are seafloor features of the accretionary prism of the Mediterranean Ridge. They have formed by the dissolution of exhumed shallow Messinian evaporites and subsequent concentration of the ultra-saline solutions in depressions on the seafloor. As an example, the horseshoe-shaped Urania basin is a DHAB south of the Peloponnese peninsula contains one of the most saline (about six times higher than Mediterranean seawater) and sulfidic (up to 15mM) water bodies of the Earth. Furthermore, its deepest part is underlain by a mud volcano that is responsible for the injection of fluid mud beneath the brine lake, with exceptionally sharp chemoclines between water column, brine, and mud layer.

We here present a model approach to reconstruct the temporal aspects of the formation, dynamics and persistence of the brine-mud-system in the deep pit of the Urania Basin. Based on data from a sampling campaign with RV Meteor (Cruise M84/1 in February 2011), we set up a one-dimensional geochemical model that integrates diffusion, reaction and advective transport and mixing. Using a set of model preconditions, we aimed to answer (1) which processes are required to maintain the current situation of steep chemical gradients of the brine-mud-system, (2) how fast the current situation could have developed under different scenarios, and (3) how long such extraordinary conditions could have persisted through Earth's history. We further discuss the consequences of the temporal framework for the evolution of prokaryotic life in this extreme habitat.