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Anhydrite blocks sinking in vertically-layered Newtonian salt structures

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Salt diapirs are internally complex systems comprising not only mechanically different salt layers, but also denser inclusions of e.g. synsedimentary anhydrite or limestone. These dense inclusions or stringers have been proposed to disturb the internal dynamics of externally stable salt diapirs and therefore potentially impose threats to the long-term stability of hazardous waste-disposal sites, some of which have been planned to be constructed in salt structures. In this study, we analyse the influence of heterogeneous salt stratigraphy on the sinking behaviour of differently-sized and -oriented dense inclusions. By using two-dimensional Finite Differences Models calculated with FDCON, we demonstrate that the sinking behaviour of dense rectangular blocks (density difference 700 kg m-3, block viscosity 1021 Pa s) in homogeneous Newtonian salt structures with a linear viscosity of 1017 Pas is a function of the block mass, aspect ratio, and orientation. This implies that (1) the sinking velocity increases with size of the block, (2) the orientation of the block (horizontal or vertical) determines the efficiency of block deformation and sinking velocity of initially horizontal blocks, (3) the deformation structures forming in the salt are generally similar, but their size depends on the width of the block (i.e. aspect ratio). In models with vertically layered salt, we placed the block at the interface between two salt formations, one with a linear viscosity of 1017 Pas, the other with a linear viscosity of 1016 or 5*1016 Pa s (in two different model series). In these models, block descent does not follow a straight downward path. Instead, the block change orientation and deforms both the adjacent salt layersintensively. Sinking velocities are strongly influenced by this sinking behaviour and deviate significantly from velocities of such blocks in homogeneous salt. A consolidated view of the results of our models shows that salt heterogeneity is a parameter that has to be considered in understanding the rate and style of descent of denser blocks within a salt structure and the type of deformation they cause within the salt as they descend. These parameters need to be taken into account during the assessment of the long-term deformation of Newtonian salt structures caused by the sinking of dense inclusions.