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Sinking velocity of boudinaged dense layer in evaporites

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Evaporite deposits commonly comprise rocks of different rheology and strongly varying density. The inverse density profile within the sequence can trigger the development of internal structures. Mechanical parameters of rocks such as viscosity and its anisotropy are the additional factors influencing the structures development. Stability of the evaporite internal structure is of particular importance for e.g. long-term repository within the salt body. Previous studies provide a broad range of settling velocities for various geometrical models. Relatively small values are derived for the case of sinking layers based on the Rayleigh-Taylor instability analysis of the layered geological media. Noticeably larger settling velocities can be obtained in the analysis of sinking dense isolated blocks.
Field observations from various salt mines show that dense layers within the salt are commonly fractured into blocks. Locally, the blocks are separated forming a torn boudinage. The mobility of such horizontally aligned blocks should be in the range between the settling velocity of the sinking layer and the isolated block. In order to gain the understanding of the sinking velocity of the boudinaged layer and where the change between the two end-members occurs, we perform a range of numerical simulations in two-dimensions using our own finite element numerical codes implemented in MATLAB. We analyse the role of 1) boudins size, 2) spacing between the boudins, 3) aspect ratio of the boudins, 4) density difference between the boudins and the embedding medium, and 5) effective viscosity of the embedding medium. We consider that the boudins are rigid and embedded in incompressible material with Carreau model for viscosity, which is capable of capturing two deformation mechanisms: dislocation creep and pressure solution. Additionally, we analyse the role of anisotropy of the embedding medium on the sinking rate.
Besides, we propose a simplified model, where the flow in between the boudins is described by the Poisseuille flow driven by the pressure gradient between the area above and below the boudins. Assuming that the block sinking is driven by the density difference and is constrained by the incompressible conditions, we derive an analytical solution for its terminal velocity. In the comparison with the numerical results, we show that our analytical solution is suitable for models with small spacing between the boudins. For large spacing between the boudins with regular shape, the analytical solution for sinking infinite cylinder in a finite box size can be employed.