
Impact of inconsistent density scaling on physical analogue models of margin-scale salt tectonics

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The influence of inaccuracies in density scaling on the structural evolution of physical analogue experiments of salt systems has been debated, and is investigated here, considering a gravity spreading example. Two-dimensional plane strain finite element numerical analysis was used to systematically evaluate the impact of changes in density scaling on buoyancy force, sediment strength, and pressure gradient. A range of densities typical of natural systems (including compacting sediment) and physical analogue experiments was included. A fundamental shift in the structure of the salt-sediment system, from diapir-minibasin pairs to expulsion rollover, was observed when sediment and salt densities were altered from values typical of physical experiments (1600 and 990 kg/m³) to those most often found in nature (1900–2300 and 2150 kg/m³). Physical analogue equivalent experiments with reduced sediment density showed diapir-minibasin pair geometry, persisting to sediment densities of ~1300 kg/m³. Salt burial by pre-kinematic sediments was found to suppress diapir formation at depths greater than ~750 m (0.75 cm at the laboratory scale). The relative importance of disproportionately high buoyancy force and low sediment strength and pressure gradient in physical experiments was investigated by isolating each of these scaling errors in turn. Buoyancy was found to be most influential in the development of diapir-minibasin pairs versus expulsion rollover geometry. Finally, demonstrating that dry physical analogue experiments with sediment density reduced to ~1140 kg/m³ (possibly through mixing with hollow glass beads) should provide a reasonable approximation of submarine salt systems in nature (including water load and hydrostatic pore fluid pressure).