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Investigating the Controls of Salt Movement Using Finite Element Modeling

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ABSTRACT

2D geomechanical modelling is used to study the field-scale evolution of two geological scenarios incorporating salt structures: (1) salt sheet advance under compression, and (2) inflation of a toe fold. The models are constructed using the finite element method, and are validated against numerical, analogue, and geological examples. A full sensitivity analysis assesses how different parameters promote or inhibit salt movement. An advancing salt sheet (1) is recreated with a 'ramp-flat' base salt geometry. Ramp development is favoured by high sedimentation rates, causing sheet inflation over peripheral buttressing strata. Wide flats develop beneath thick sheets, expressing significant forward motion that can cause overturning of peripheral strata and sub-salt shear zone development. Sheets with a thick initial overburden develop smoother base geometries, increasing interpretation complexity. The basinward limit of salt on a margin experiencing compression (2) is a high strain environment subjected to considerable buttressing effects. High compression rates and overburden thicknesses favour development of a toe thrust, while high sedimentation rates and salt layer thicknesses favour a toe fold. These results are demonstrated with reference to case studies, and we discuss their implication on salt flow mechanism predictions, stratal geometries, damage zone distributions and fracture orientations. The models developed here enable high-resolution, geologically realistic reconstructions of salt structures, and may guide interpretation in areas with sparse or poor seismic imaging.