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Stress Perturbations and Strain Localization in Evolving Fold-and-Thrust Structures—Insights from Numerical Models

Two-dimensional finite element models are used to study the mean stress distribution and reorientation of stress fields as well as strain localisation and the related change in fracture porosity in evolving fold-and-thrust structures. Model geometries are based on sequences of geometrically restored sections through various thrusts and thrust fault-related folds. In detail, fault-propagation folds, fault-bend folds, detachment folds and duplex structures are examined. For each type, scenarios with syn-tectonic sedimentation and erosion as well as with siliciclastic and carbonate lithologies are studied.

Following a comparative discussion of the modelling results achieved for the various scenarios, special focus is on the calculated mean stress pattern as a tool to predict fluid flow in active thrustbelts by sucking and pumping thrust sheet mechanisms. In fault-propagation fold models, for example, strong mean stress gradients between hanging wall and footwall develop already during the early convergence stages. Resulting fluid flow between mean stress maxima and minima provides an effective and long-lasting driving mechanism for hydrocarbon migration to source reservoirs in the foreland.