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Finite-difference numerical modeling of sub-thrust inversion tectonics

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In collisional foredeeps, rifted continental margins become buried by foreland sedimentary deposits and, ultimately, are overridden by advancing fold-and-thrust belts. With ongoing collision, stresses are transmitted into the foreland plate, causing positive inversion of buried rift basins in the sub-thrust region; ultimately, rift basins may become incorporated into the thrust system. This process indicates the co-existence of two crustal detachments soled at different depths within forelands: i) a shallow level décollement decoupling molasse-type sequences from the underlying basement and ii) deep-rooted lower crustal shear zones causing thick-skinned deformation. The activity of those detachment horizons is governed by different environmental conditions and deformation mechanisms. As today, dynamic strain weakening of brittle faults and fluid overpressures are recognized as fundamental parameters controlling fault reactivation necessary for basin inversion. In natural systems, however, these two factors have to compete against the lithostatic load imposed by the advancing fold-and-thrust belt.
To test the relative influence and potential feedbacks of these parameters for the reactivation and inversion of rift basins beneath fold-and-thrust belts, we have carried out a series of numerical simulations applying a fully-vectorised 2D finite-difference code with marker-in-cell technique and a visco-elasto-plastic/brittle rheology. The two main parameters investigated are the strength of high-strained fault zones and the fluid overpressure of the syn-rift sequences.
Results indicate that the structural evolution of the fold-and-thrust belt is affected by the competition between the strength of weakened faults and that of syn-rift strata. Relatively weak inherited fault zones lead to sub-thrust basin inversion by fault reactivation, whereas highly overpressured syn-rift strata favour the formation of hanging-wall bypass thrusts rather than fault reactivation.