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Mechanical analysis of the thin- versus thick-skin tectonics in the Molasse basin and Jura thrust belt (Swiss Alps)

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The Jura fold-and-thrust belt is classically interpreted as a thin-skin belt developed over a triasic décollement, which is itself topping Permo-carboniferous E-W transpressive grabens delimited by N-S strike-slip faults. These faults have been reactivated in eo-oligocene times as normal faults. Today, the basement is seismically active, suggesting that the Jura belt involves some amount of basement deformation. We tested both thin and thick-skin hypotheses using a simple rheological prototype with two potential décollements : a Triassic horizon extending below Jura and Molasse basin, and the upper-lower crust interface rooted deep south of the Alpine front close to the Penninic nappes region. Using the theory of limit analysis combined with automatic adaptive meshing, we demonstrate that the main Jura Triassic décollement can be activated with the present day topography, if its friction angle is below 5°, a counter-intuitive result, that was not foreseen by sand box models. In contrast, a thick-skin deformation involving all the upper crust is possible either only south of the Jura below the topographic depression of the Molasse basin if the upper-lower crust interface has an equivalent friction angle above 4.6°, or far beyond it towards the North, if it is weaker. Active thick-skin thrusting within the Jura belt requires further assumptions on the existence of weak zones, for which a good candidate could be the inherited eo-oligocene normal faults as previously suggested in the litterature. We also demonstrated the potential major role of the topographic depression of the Molasse basin in conveying deformation from the Alps to the Jura, and in localising thick-skin thrusting.