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Sedimentary loading-unloading cycles and faulting in intermontane basins: insights from numerical modeling and field observations in the NW Argentine Andes

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The removal, redistribution, and transient storage of sediments in tectonically active regions is thought to exert a first-order control on shallow crustal stresses, fault activity, and hence on the spatiotemporal pattern of deformation in mountain belts. Accordingly, sediment loading and unloading cycles in intermontane sedimentary basins may inhibit or promote intrabasinal faulting, respectively, but unambiguous evidence for this potential link is elusive so far. Here we combine 2D numerical experiments that simulate contractional deformation in a broken-foreland setting with field data from intermontane basins in the NW Argentine Andes. Our modelling results suggest that thicker sedimentary fills (> 0.7-1.0 km) suppress basinal faulting processes, while thinner fills (< 0.7 km) tend to delay faulting. Conversely, the removal of sedimentary loads via fluvial incision and basin excavation promotes renewed intrabasinal faulting. These results elucidate the tectono-sedimentary history of intermontane basins in northwestern Argentina. Here, the Santa Maria and the Humahuaca basins record intrabasinal deformation during or after sediment unloading, while the Quebrada del Toro Basin documents the suppression of intrabasinal faulting due to loading by coarse conglomerates. We conclude that sedimentary loading and unloading cycles exert key control on spatiotemporal deformation patterns in intermontane basins of tectonically active broken forelands.