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3D thermo-mechanical modelling of oblique continental collision: relative role of slab tearing in along-strike topography evolution

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It is assumed that slab tearing (or the lateral propagation of slab break-offs) in collisional belts controls the progressive along-strike uplift of mountains and the development of adjacent basins. However, differential continental collision due to obliquity or other irregularities of the original passive margin can introduce additional complications and influence the progressive topographic growth. Here, we use a 3D thermo-mechanical numerical modelling approach to distinguish the topographic response to slab break-off propagation from the surface uplift caused by along-strike differential collision. To this end, we examine the effects of several key factors, including (1) the obliquity of the passive margin, (2) the age of the oceanic slab, (3) the rate of convergence between colliding plates, and (4) the presence of a microcontinental block between passive and active margins. In all experiments, slab break-off initiates earlier than continental collision due to the transition from oceanic to continental subduction beneath the fore- and back-arc domain formed during the previous retreat of the subduction zone. The topographic uplift associated with slab tearing is more pronounced and spreads laterally much faster than in the subsequent collision phase. The parametric analysis shows that the lateral migration of the continental collision is controlled by the convergence rate, while the horizontal velocity of slab tearing depends mainly on the obliquity angle and slab age. The presence of additional structural complexity - a microcontinental block that has detached from the passive margin - leads to a transition from horizontal to vertical slab tearing and to more intense syn-collisional mountain growth.