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Subduction and break-off controls on Indentation tectonics and Western Syntaxis formation during India-Asia convergence

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The indentation of the Indian plate into the Asian lithosphere is one of the most spectacular features of plate tectonics. Large deformations of the Himalayan front and Asian continental interiors are the result of the interaction between the subducting Greater India and the Asian upper plates during convergence. However, how deep subduction and indentation tectonics are coupled remains unknown. Revising the links between Asian tectonics and subduction of Tethys, Greater India and the breakoff episodes imaged in tomography allows formulating hypotheses on the interaction mechanisms operating. These are tested using self-consistent three-dimensional numerical models of coupled subducting – upper plates in an ambient mantle. We find that the subduction of the buoyant continent progressively decreases the driving force available and is followed by a convergence velocity drop, similar to the observed, however deformation is mostly accommodated along the upper plate margin. When slab detaches during subduction, similar convergence rates are sustained, yet transient stresses propagate far into the upper plate interiors, localising along a belt at a high angle with the trench. Breakoff at the ocean-continent boundary confers long-lived complex slab morphology, with shallow upper-plate underthrusting laterally stepping to steeper dip along the trench. Following breakoff, the trench curvature progressively increases as convergence proceeds. The model features are compatible with those of the India-Asia convergence zone, with the large underthrusting of the Indian lithosphere and subduction far north of the Himalayan front and beneath the Hindu-Kush, to the west, and the lateral variation to the east, where long-term Indian subduction occurred along a margin located closer to the actual front. Our models allow explaining the development of the Western Syntaxis as the consequences of the breakoff. By inference, the breakoff episodes likely provided the conditions for large stress surge in the Asian lithosphere that resulted in the formation of the long-lived major intra-continental faulting systems of the Red River-Altyn Tagh and Tien Shan.