Effects of an oblique collision on the evolution of foreland basins: Insights from 3D numerical modeling

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Flexural bending of a downgoing subducting plate in response to forces from slab pull and topographic load leads to foreland basin development in front of growing mountain belts. Many foreland basins worldwide show along-strike variable basin architecture and subsidence history. Various factors such as lateral variations in slab pull, the presence of lateral crustal heterogeneity, slab breakoff and tear propagation have been suggested as drivers. However, the effects of an oblique continental collision on the evolution of foreland basins are largely ignored. In this study, we use 3D thermo-mechanical numerical models coupled with surface processes (i.e., sedimentation and erosion) to simulate an oblique collision. In the initial model, the continental plate margin is placed at an oblique angle relative to the subduction trench and we vary the following parameters: (1) margin obliquity, (2) convergence velocity, (3) age of the subducting oceanic lithosphere, and (4) presence of pre-existing rigid blocks in the subducting plate. Our results show that models with no obliquity (i.e., straight continental margin) create simultaneous along-strike continental collision and foreland basin subsidence. However, higher margin obliquity ($\geq 15°$) causes a delay in the along-strike collision and foreland basin development. Our results suggest that the along-strike propagation of foreland basin development is controlled by the initial margin obliquity and plate convergence velocity. Finally, we discuss the implications of our study on the 3D evolution of the Northern Alpine Foreland Basin (NAFB) and intramountain basins within the Betics where along-strike variations of the sedimentary basin architecture are reported.