EGU23-812
https://doi.org/10.5194/egusphere-egu23-812
EGU General Assembly 2023

Effects of deep lithospheric processes and lateral crustal heterogeneity on the 3D evolution of foreland basins

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Foreland basins develop in front of growing mountain belts due to the flexure of the downgoing plate in response to forces from slab pull and a topographic load. Many foreland basins worldwide show along-strike variable basin subsidence and architecture. Various factors such as lateral variations in slab pull, rheology and stress transfer, topographic loading of the adjacent mountain belt, presence of lateral crustal heterogeneity, slab breakoff, and its lateral tearing propagation have been suggested as drivers. However, the quantification of these factors is still lacking.

In this contribution, we study the effects of slab break-off and tearing on the along-strike variations in foreland basin subsidence and deposition in a collisional setting. We also consider the heterogeneities of the lower plate continental margin by taking into account the presence of a microcontinent (i.e. Brianconnais high), being formed during a preceding extensional phase. To do so, we use 3D thermo-mechanical numerical models coupled with surface processes, such as sedimentation and erosion to investigate the effects of the following parameters on the foreland basin evolution: (1) convergence velocity, (2) age of the subducting oceanic lithosphere, (3) length of the subducting slab, (4) continental margin obliquity relative to the trench, and (5) presence of pre-existing rigid blocks in the downgoing plate.

Our preliminary results show that younger age of the subducting oceanic slab (≤ 50 Ma) facilitate slab breakoff and basin uplift during continent-continent collision. On the other hand, the higher margin obliquity (≥ 15°) causes a delay in the propagation of slab breakoff along the strike, i.e. lateral tearing. This process leads to diachronous basin subsidence and uplift along the strike. Finally, we discuss the implications of our results on the 3D evolution of the Northern Alpine Foreland Basin where slab breakoff and subsequent lateral tearing have been proposed as a probable controlling factor leading to the along-strike variations of the sedimentary basin architecture.