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Quantifying the timing and extent of syn-orogenic sedimentation in the southern Pyrenean foreland using low-temperature thermochronology

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The southern central Pyrenees have figured prominently in studies of external wedge building, thrusting sequences and interactions between tectonics and surface processes. This is mainly due to the exceptional exposure of syn-tectonic strata and the quality of the ECORS seismic profile shot through this area. Nevertheless, no low-temperature thermochronological data has been published from the foreland fold-and-thrust belt, except in the conglomeratic massifs, which revealed the timing of the episode of rapid erosional unroofing of the Axial Zone. Using thermo-kinematic modeling of the thermal evolution of the Southern Axial Zone we have shown that the conglomerates could have prograded toward the hinterland until 30 Ma and remained stable until 9 Ma. From the late Miocene to the present, valley incision was interpreted as the onset of the excavation of the Ebro basin when it opened to the Mediterranean. Moreover, the estimated thickness for the deposits on the southern flank of the Axial Zone is of $\sim$2 km. We thus propose here to extrapolate this scenario to the southern Pyrenean foreland, where no data were available to test our model predictions. Apatite (U-Th)/He thermochronology is a powerful tool to quantify the exhumation in fold-and-thrust belts as the closure temperature is relatively low (75 $\pm$15 °C). Yet, this thermochronometer is very sensitive and requires high-quality samples, making the application of this method quite difficult in sedimentary terrains.
We present new apatite fission-track and apatite (U-Th)/He data of sandstones collected in the Tremp-Graus and Ager basins to provide estimates of the thickness and extent of the overlying conglomerate deposits, as well as to further constrain the timing of excavation of the basin.
Double dating on sedimentary apatites allows us to obtain consistent T-t paths using the He-diffusion kinetics that are a function of radiation damage and its annealing. This study reveals the importance of combining AFT and AHe jointly to provide sustainable constraints on thermal history in sedimentary rocks. The modeling all predict a burial from Late Cretaceous to Miocene-Pliocene times to reach temperatures of 60 to 105°C, equivalent to 1.8 to 3.2 km of burial. The timing for the onset of exhumation is from 20 to 1 Ma, with an average time of 9.5 Ma. We also infer from this modeling that an Albian exhumation phase is represented by a majority of grains.
The reasons for age scatter of our AHe dataset were also investigated and reveal an important contribution of the eU content, as well as the influence of the pre-depositional history, for explaining these ages. We show that despite relatively scattered AHe ages, we could perform thermal modeling and obtain consistent Mesozoic to Cenozoic exhumation histories for 3 samples.