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Evaluating balanced section restoration with thermochronological data

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Crustal-scale balanced section restoration is an elaborate procedure that requires a great understanding of not just the present-day geology and the history of the area in question, but also the processes acting on the deep structures as well as those playing a role in the formation of topography. Integration of all available geological and geophysical data is needed to constrain a restoration that is consistent with the observations and which explains the present-day features in the simplest possible way. In most cases these restorations are non-unique and their consistency with independent data – in particular thermochronological data that constrain spatial and temporal patterns of exhumation – is difficult to assess.

As part of the Topo-Europe project PYRTEC, we use a simplified version of the area-balanced, crustal-scale restoration of the ECORS seismic section in the Central-Pyrenees constructed by Muñoz (1992) and Beaumont et al. (2000). This transect is well suited for our purposes as the restoration is well constrained and supported by a wide variety of geological and geophysical data. Moreover, an extensive thermochronological dataset, including apatite and zircon fission-track, (U-Th)/He, mica, and feldspar Ar-Ar ages is available for the area.

Using 2D-Move software, we have created a displacement field that describes the kinematics and internal deformation of different crustal blocks, focusing on the three central thrust sheets of the section – the Nogueres, the Orri and the Rialp – as these make up the Axial Zone where basement is exposed and as the available thermochronological data mainly cover these thrusts. Using a time-averaged velocity field derived from the displacement field, reconstructed using 2D-Move and the geometry of the restored section as input for the thermo-kinematic model Pecube (Braun, 2003) we can make predictions of the thermal history of any location along the transect and convert this into different thermochronological ages using laboratory-calibrated age-prediction models. A comparison of predicted and observed thermochronological datasets can then be used to test the consistency of the section balancing with the observations, evaluate the kinematic history inferred from the balanced crustal cross section through the Central Pyrenees, and constrain paleotopography of the orogenic belt.