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Deep structure and collisional processes in the Western and Central European Alps

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We investigate both the deep crustal structure of the Western and Central Alps orogenic wedge and the timing and amount of convergence accommodated since 32 Ma. The new structural interpretations are based on the most recent geophysical models (Vs and Vp tomography mainly) coupled to geological surface information. We show that first-order similarities in collision kinematics can be described from the Western to the Central Alps. After the subduction-collision transition (37-32 Ma), from around 32 Ma and until 22-20 Ma, the shortening consists of distributed deformation throughout the doubly verging orogenic wedge. From around 20 Ma until recent times, the orogen was controlled by localized west- or northwest-verging thrusts below the External Crystalline Massifs. This probably witnesses localization processes in the proximal European crust (i.e., below the Penninic Frontal Thrust) on a 10 Myr timescale. These structures (both distributed and localized ones) root in middle- to lower crustal low velocity (Vs) zones interpreted as a thick shear zone acting as a deep, crustal decollement. The low seismic velocity is most probably controlled by active fluid circulations, structural anisotropy, and/or metamorphic Alpine paragenesis (amphibolite facies). Thus, the 10 Myr timescale may correspond to characteristic time for the localization processes within the deep, ductile decollement.

Along-strike significant differences from Western to Central Alps can also be highlighted. Beyond collisional magmatism and amphibolite facies metamorphism only present in the Central Alps, kinematical differences can be quantified. In the Western Alps, after the first phase of collision, at around 20 Ma, the orogenic wedge consisted in a West-verging wedge while in the Central Alps, North- and South verging structures remained active. These differences imply significant contrasts in terms of convergence rates that can be quantified through balanced cross sections with realistic inherited Mesozoic structures. In Central Alps, convergence rates were about 1.2 +/- 0.2 cm/yr from 32 to 22 Ma and about 0.3 +/- 0.1 cm/yr from 22 to 0 Ma. This strongly suggests that before collision s.s., i.e. before 32 Ma, the convergence rate was higher than 1.2 cm/yr.

While similarities in terms of structural styles and kinematics in both parts of the orogen most likely reflect crustal rheology and localization processes, the differences allow discussing the influence of both the inherited Mesozoic structure and the kinematics of Adria after the subduction phase.