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# Exhumation mechanisms in convergence zones: Insight from thermomechanical models (The case of the Western Alps)

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Convergence zones present very different morphologies depending on the type of the lithosphere involved (oceanic or continental). In the same way, the content of buried material is also different (oceanic crust, continental crust, sediments). Field and metamorphic P-T-t data suggest contrasting exhumation modes for these different materials (e.g., structural location within the orogenic belt, shape of the P-T path, exhumation rates). We herein present several numerical subduction models that are implemented using the thermo-mechanically and thermo-dynamically coupled code PARA(O)VOZ. The results of our models are compared with the available data for the alpine belt, where the continental subduction of the European passive margin followed the oceanic subduction of the Liguro-Piemontese ocean. They show that:

(1) Our experiments can successfully reproduce natural data (topography, morphology and P-T-t paths).

(2) In the oceanic subduction context, exhumation of sediments within a steady sedimentary accretionary wedge occurs only if the overriding continental plate has a strong lower crust, if the sediments have a high viscosity and/or a low density, and if the convergence rate is slow ($\sim$30 mm.an$^{-1}$). Moreover, exhumation of oceanic crust occurs only in the presence of a weak serpentinite layer located below the subducting oceanic crust.

(3) In the continental subduction context, our experiments reproduce the reported bi-phase evolution of exhumation rate of high-pressure rocks, fast at mantle depths ($>$10 mm.yr$^{-1}$) and slow at crustal depths ($<$4 mm.yr$^{-1}$). Such a bi-phase evolution is more pronounced for slow convergence rates. UHP exhumation in a slow convergence context also requires the presence of a double-layered continental crust for the subducting plate, and leads to self-localization of non-predefined crustal "separation zones" near the level of the brittle-ductile transition, from which the low-density continental material is exhumed.

(4) The syn-convergent exhumation of continental material at the rear of the accretionary wedge is a transient process ($<$ 10 Myr) that is largely controlled by the balance of buoyancy and viscous forces within the depth interval of 35-100 km and by erosion at shallower depths ($<$ 35 km). Our models also indicate that slab break-off does not have a significant impact on the rates of exhumation.