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Burial and exhumation in a subduction wedge: mutual constraints from thermo-mechanical modelling and natural P-T-t data (Schistes Lustrés, Western Alps)

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Despite the growing amount of data on surface horizontal displacements, constraints on the vertical movements and processes at convergent plate boundaries are still limited. As a result, the mechanisms responsible for the syn-convergence exhumation of high pressure low temperature (HP-LT) metamorphic rocks in oceanic accretionary wedges remain poorly known. Analytical corner flow models were developed and natural P-T-t paths were gathered during the past twenty years but without real cross-checking. The present study aims at getting better constraints on the viscosity, thermal conductivity, and chemistry of the sediments in the subduction zone. Oceanic subduction is modelled using a forward visco-elasto-plastic thermo-mechanical model (PARA(O)VOZ algorithm) that takes into account progressive density changes using the thermodynamic code THERIAK. In order to validate or invalidate the different models, synthetics P-T-t paths are generated out of numerical simulation using passive markers and compared with natural P-T-t paths, notably in terms of exhumation rates.

Our study is focused on oceanic remnants of the Alpine subduction, with particular emphasis on the Schistes Lustrés (SL) complex of the Western Alps, which is thought to represent the fossil accretionnary wedge of the Liguro-Piemontese ocean.

We show that for convergence rates comparable to those of the Alps during subduction (c. 3 cm/yr) the accretionary wedge may remains stable over long time scales (c. 20 Ma) and that a significant part (c. 35%) of sediments entering the wedge undergoes P-T conditions typical for the SL complex (around 15-20 kbar and 350-450˚C). During the first 5 Ma, the metasediments are exhumed at relatively fast rates (c. 4-10 mm/yr). Later, the exhumation rates slow down to rates of 1-4 mm/yr which are in better agreement with observed P-T-t paths. Two alternative explanations are possible for these high exhumation rates predicted for the earlier stage of exhumation: either the "observed" exhumation rates are slightly underestimated (possibly due to the presence of minor excess of ^{40}Ar in the SL rocks) or these rates correspond to a transient exhumation rate before accretion reaches a steady state. Noteworthily, no exhumation of oceanic units subducted below the accretionary wedge ever takes place during oceanic convergence.