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Thermal structure of the Préalpes: constraints on their geodynamic evolution during subduction

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The Préalpes form a series of Klippen in the northwestern part of the Alpine Chain. These Klippen consist of a pile of thin (< 2 km thick), but long (> 15 km) cover nappes, thrusted on top of the Ultrahelvetic nappes and partly on top of the Molasse Basin. From top to bottom, the nappes are derived from the Liguro-Piemont Ocean, the Briançonnais continental sliver, and the Valais Ocean, respectively. Hence the architecture of the nappe pile is the same as that described in the internal part of the orogen. 40Ar/39Ar analyses on fine-grained illite grain-fractions suggested that burial of the Préalpes Médianes began around 47-40 Ma (Jaboyedoff and Cosca, 1999), hence during Alpine subduction. The Préalpes have classically been considered as non-metamorphic, thus detached in an early phase of Alpine subduction, in spite of metamorphic temperatures up to 300 or 400°C (Mosar et al. 1996), and a poorly-defined trend of T increasing towards the SE. However, metamorphic T have only been inferred on the base of illite crystallinity, and no absolute T values were attributed to the single samples analysed.
The present study presents a series of new T data derived from the Raman analysis of carbonaceous material within 40 samples collected along a section perpendicular to the trend of the French Préalpes. These data provide the maximum T attained by the samples during the Alpine history. The lower T samples lie below 200°C, the lower limit of calibration of the RSCM method, and the highest T attain 250°C. These T values are found in the upper most nappes, derived from the Liguro-Piemont Domain. These Units lie above the Ultrahelvetic nappes whose maximum T are well below 200°C. This result confirms the idea of an early, low T metamorphism of the Préalpes that took place before their transport on the external part of the orogen.
Assuming a geothermal gradient related to subduction, the maximum T of 250° C points to the attainment of > 20 km depth before detachment and nappe stacking. The latter T value also indicates the presence of a large gap in metamorphic T between the cover nappes of the most external part of the orogenic wedge and their analogs exposed in the internal part of the orogen, suggesting different paleo-depths of detachment for these two areas. Within the nappe stack of the Préalpes, the small temperature differences observed suggest that the Liguro-Piemont nappes were subducted to greater depth than the other units of the Klippen. This temperature difference is in agreement with structural observations indicating a much more penetrative and ductile deformation of the upper nappes (Liguro-Piemont-derived) compared to the lower ones (Briançonnais and Valais- derived).
Additional data will show whether T gradients within the nappes themselves can be detected and whether systematic gaps between the nappes exist, allowing to refine a model of formation and stacking of the nappe pile.