# *Deciphering the geodynamic evolution of the Alps: what is the contribution of the metamorphic petrology?*

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Ernst (1971) used the plate tectonic concept to propose the first modern model for the metamorpic evolution of the Alps. In the meantime, Frey (1969) and Trommsdorff (1966) respectively investigate metamorphism in isochemical systems provided by shales and siliceous carbonates. This provided quantitative constraints on the Cenozoic temperature evolution in the Central Alps. Frey et al. (1999) compiled all available information on the peak temperature distribution and used the occurrence of eclogites to unravel the dynamics of the Alpine evolution. This paper presents the regional distribution of late Cretaceous-Tertiary metamorphic conditions as documented in post-Hercynian metasediments across the entire Alpine belt from Corsica-Tuscany to Vienna. Based on metamorphic studies in metasediments, we document substantial differences in the metamorphic, and hence the geodynamic evolution along strike of the Alpine orogen.

The Western Alps did not reach the mature stage of a head-on collisional belt as indicated by a continuous metamorphic evolution representing all subduction-related processes occurring from lower greenschist to UHP conditions. All the metamorphic rocks behind the Penninic frontal thrust were already exhumed to upper crustal levels during ongoing oceanic and continental subduction and before collision with the Dauphinois domain from around 32 Ma onwards. Hence, the Western Alps represent a frozen-in subduction zone. Since then, only exhumation by erosional processes affected the inner parts of the orogen.

The rest of the Alpine orogen later underwent a more important collision determined by the head-on geometry of subduction and collision. This part of the orogen therefore often (but not always) shows a bimodal metamorphic evolution with two distinct P and T peaks. The intensity of the thermal overprint relates to the amount of crustal material incorporated into the orogenic wedge. Thermal overprint is primarily related to the amount of crust involved in the subduction and collision processes rather than to processes of shear or viscous heating. The latter mechanism, which require high deformation rates, do not favour the preservation of HP-LT assemblages within high-grade rocks. The recorded isotopic data reveal a significant time gap on the order of 20 Ma between the subduction-related HP/LT event (42-40 Ma) and the later collision-related MP/MT Barrovian overprint (19-18 Ma). This supports the notion of a polymetamorphic evolution in the Central Alps associated with a bimodal P-T path. Amphibolite-facies Barrow-type overprint represents a separate heating pulse that post-dates isothermal decompression after the early high-pressure stage. This considerable time interval is in accordance with the interpretation that the accretion of vast amounts of European continental crust (forming the present-day Lepontine dome) provided high radiogenic heat production responsible for amphibolite-facies metamorphism during an entirely conductive and therefore rather slow process.

The Tuscan and Corsican areas show two different kinds of evolution, with Corsica resembling the Western Alps, whereas the metamorphic history in the Tuscan domain is complex owing to the late evolution of the Apennines. Careful analysis of the metamorphic evolution of metasediments at the scale of an entire orogen may change the geodynamic interpretation of mountain belts.