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The role of post-orogenic inheritance for the formation of rifted margins: Example of the Alpine Tethys

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Rifting, leading eventually to the formation of an ocean, often develops over a region, which was previously affected by orogenic and post-orogenic processes. This contribution aims to investigate the role of structural, lithological and thermal inheritance resulting from late- to post-orogenic processes on the formation of subsequent continental rifted margins.

The Alpine belt in Western Europe preserves a complete Wilson Cycle, spanning from Devono-Carboniferous Variscan orogeny, over Permian post-Variscan extension and Jurassic rifting to Late Cretaceous-Tertiary Alpine orogeny. In detail, the Permian post-Variscan extension represents a critical event that strongly modified the architecture and the composition of all crustal levels. The upper crust recorded the formation of intracontinental sedimentary basins associated with extrusive magmatism. Mid-crustal levels were characterized by the development of mylonitic shear zones and the emplacement of felsic to mafic plutons, while the lower crust was mainly intruded by mafic magmas locally associated with high-temperature (HT) metamorphism.

The strong structural and lithological inheritance resulting from Permian post-orogenic processes has a key control on the evolution of the subsequent Jurassic rifting during the Alpine Tethys opening: (1) The location of Jurassic rift basins was – at least locally – controlled by Permian sedimentary basins, (2) Jurassic structures accommodating crustal thinning reactivated Permian shear zones, (3) Permian mafic plutons may represent rigid bodies in the continental crust controlling the localization of the Jurassic deformations, (4) the pre-rift lower crust was likely strong and refractory due to the emplacement of mafic underplated bodies and associated HT-metamorphism, and (5) the pre-rift lithospheric mantle was already depleted at the onset of the Jurassic rifting as being the source of Permian mafic magmas.

In conclusion, post-orogenic processes strongly modified the composition and the architecture of the continental lithosphere prior to the subsequent overprint during rifting. These results highlight the complex nature of the continental lithosphere at the onset of rifting. Therefore, a better understanding of these pre-rift conditions is necessary to further unravel the mechanisms of extension of the continental lithosphere such as the localization of deformation and the occurrence or absence of syn-rift magmatism.