EGU26-4503, updated on 13 May 2026
https://doi.org/10.5194/egusphere-egu26-4503
EGU General Assembly 2026

2D numerical models of the Variscan post-collisional evolution:example from the Valpelline Series (western Alps)

Alessandro Regorda[1], Marco Filippi[1], Manuel Roda[1], Fabiola Caso[2], Chiara Benedetta Piloni[1], Federico Farina[1], and Michele Zucali[1]
[1]Università degli Studi di Milano, Earth Sciences, Milano, Italy (alessandro.regorda@unimi.it)
[2]Università degli Studi di Milano-Bicocca, Earth and Environmental Sciences, MIlano, Italy

The Carboniferous-Permian evolution of the Variscan belt, marking the transition from continental collision to post-collisional extension, is particularly difficult to investigate because the post-collisional metamorphism overprints the previous history of subduction and collision. In fact, the collision is followed by widespread high- to ultra-high-temperature metamorphism in the early Permian (e.g., Schuster and Stüwe, 2008), interpreted as the expression of a large-scale transtensional regime linked to active shear zones across Pangea (Muttoni et al., 2003). In addition, uncertainties in Pressure-Temperature (PT) estimates and metamorphic geochronology complicate the discrimination of successive events.
In this study, we focus our analysis on the Valpelline area where the Variscan post-collisional evolution is well preserved. The rocks in the area offer the possibility of integrating high-precision age determinations with robust PT constraints, allowing the discrimination of two closely spaced metamorphic events (M1 and M2) separated by only a few Myr (Filippi et al., 2025). We compare these PT constraints with predictions obtained from 2D thermo-mechanical numerical models performed with the FALCON code (Regorda et al., 2023), to investigate the evolution of convergent–divergent tectonic systems, with particular emphasis on post-collisional processes. In particular, we developed three models characterised by different durations of an intermediate gravitational phase before the beginning of the extension.
Our simulations indicate that the onset of post-collisional divergence promotes the reactivation of structures inherited from the preceding convergence phase. In fact, extension in the upper crust is accommodated by normal faulting associated with the reactivation of pre-existing compressional structures. This evolution leads to the progressive thinning of the thickened continental crust, driven by asthenospheric upwelling beneath the slab. This process is enhanced by relatively high temperatures and reduced viscosities at the base of the subducting plate compared to that of the mantle wedge, which favour efficient strain localization. In addition, the agreement between model predictions and high-precision PT estimates and geochronological data indicates that the initiation of a divergent tectonic regime shortly after collision (within a maximum of 5 Myr) is required to explain the observed metamorphic evolution of the Valpelline rocks.

References

M. Filippi, F. Farina, M. Ovtcharova, F. Caso, M. Roda, C. B. Piloni, and M. Zucali. High-precision zircon geochronology constrains early permian exhumation of the deep adriatic crust in the western italian alps. Earth and Planetary Science Letters, 671:119689, 2025. doi:10.1016/j.epsl.2025.119689.

G. Muttoni, D. V. Kent, E. Garzanti, P. Brack, N. Abrahamsen, and M. Gaetani. Early permian pangea ‘b’ to late permian pangea ‘a’. Earth and Planetary Science Letters, 215(3):379–394, 2003. doi:10.1016/S0012-821X(03)00452-7.

A. Regorda, C. Thieulot, I. van Zelst, Z. Erdős, J. Maia, and S. Buiter. Rifting venus: Insights from numerical modeling. Journal of Geophysical Research: Planets, 128(3): e2022JE007588, 2023. doi:10.1029/2022JE007588.

R. Schuster and K. Stüwe. Permian metamorphic event in the Alps. Geology, 36:603–606, 2008. doi:10.1130/G24703A.1.