What drives Alpine Tethys opening: suggestions from numerical modelling

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We discuss the results obtained for two subsequent numerical models that simulate the evolution of the European lithosphere from the late collision of the Variscan chain to the Jurassic opening of the Alpine Tethys. The first model accounts for the evolution of the crustal lithosphere after the Variscan subduction and collision (300 Ma) up to 220 Ma (Marotta et al., 2009). The second model accounts for the rifting of the continental lithosphere from 220 Ma up to reach the crustal breakup and the formation of the oceanic crust (Marotta et al., 2016). For both models, different initial geodynamic configurations have been tested and we compare the results with natural data of Permian-Triassic metamorphic rocks and Jurassic gabbros and peridotites, to evaluate which configuration best matches the observations. Natural data belong to different structural Alpine domains. Continental rocks are collected from Helvetic and Penninic domains (European paleomargin) and from Austroalpine and Southalpine domains (Adriatic paleomargin) and oceanic rocks are collected from Alpine and Apennine ophiolites. The comparison is made in terms of contemporaneous agreement to lithology, pressure and temperature values, and ages. The comparison between Permian-Triassic to Jurassic natural data from the Alps and the Northern Apennines and two subsequent numerical models simulating the evolution of the lithosphere from the late collision of the Variscan chain to the Jurassic opening of the Alpine Tethys suggests that: i) a forced extension of the lithosphere results in a thermal state that better agrees the Permian-Triassic high temperature event(s) than a solely late-orogenic collapse; ii) a rifting developed on a thermally perturbed lithosphere agrees with a hyperextended configuration of the Alpine Tethys rifting and with the duration of the extension up to the oceanization. These results suggest that the Alpine Tethys rifting and oceanization developed on a lithosphere characterized by a thermo-mechanical configuration consequent to a post-Variscan extension affecting the European realm during Permian and Triassic. Therefore, a long-lasting period of continuous active extension can be envisaged for the breaking of Pangea supercontinent, starting from the unrooting of the Variscan belts (~300 Ma), followed by the Permian-Triassic thermal peak highlighted by HT-LP metamorphism and gabbros emplacement, and ending with the crustal breakup and the formation of the Alpine Tethys ocean (170-160 Ma). This process could be characterized by alternated period of active extension and stasis, as proposed for the Northern Atlantic rifting or as envisaged for the Ivrea-Verbano Zone based on three metamorphic ages.

Marotta, A. M., Roda, M., Conte, K. and Spalla, M. I.; 2016. Thermo-mechanical numerical model of the transition from continental rifting to oceanic spreading: the case study of the Alpine Tethys. Geological Magazine, 1-30.

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