Geophysical Research Abstracts
Vol. 17, EGU2015-3319, 2015
EGU General Assembly 2015

From rift-inherited hyper-extension to orogenesis: De-coding the axial zone of orogenic belts

Marco Beltrando (1), Gianreto Manatschal (2), and Geoffroy Mohn (3)

(1) Dipartimento di Scienze della Terra, Università di Torino, Torino, Italy (marco.beltrando@unito.it), (2) IPGS, CNRS-EOST, Université de Strasbourg, Strasbourg, France, (3) GEC, Université de Cergy-Pontoise, Cergy F-95 000, France

The relative role of rift-inherited hyper-extension and subduction/collisional dynamics in establishing the lithostratigraphic associations and overall architecture of orogenic belts has been investigated for the Western Alps. This case study was selected to test existing models involving complex subduction/exhumation dynamics to account for seemingly chaotic mixing of continental crust and serpentinized mantle rocks in high-pressure metamorphic units. The methodology developed to assess the role of rift-inheritance in multiply deformed/metamorphosed tectonometamorphic units stems from recent advances in the understanding of hyper-extended domains in present-day magma-poor rifted margins, where the crustal architecture displays transitional features between typical oceanic and continental domains. In these areas, slivers of hyper-extended continental crust or pre-rift sediments may rest as extensional allochthons upon serpentinized mantle, while syn- and post- rift sediments seal the extension-related lithostratigraphy.

Following multi-stage orogeny-related deformation and metamorphism, this rift-related lithostratigraphic architecture can erroneously be ascribed to complex subduction dynamics, partly due to the sliver-like appearance of continental basement. However, the partial preservation of rift-related lithostratigraphic associations may still be assessed by (1) the consistency of the lithostratigraphic architecture over large areas, based on the continuity of key surfaces (i.e. base of early post-rift sediments) across the orogeny-related macro-structures, (2) the presence of clasts of basement rocks in the neighboring meta-sediments, indicating the original proximity of the different lithologies, (3) evidence of brittle deformation in continental basement and ultramafic rocks pre-dating Alpine metamorphism, indicating that they were juxtaposed by fault activity prior to the deposition of post-rift sediments, and (4) the similar Alpine tectono-metamorphic evolution of ophiolites, continental basement and meta-sediments. The partial preservation of rift-related relationships despite subduction to (U)HP conditions indicates that the association of serpentinites and continental basement, which in the Western Alps has often been ascribed to chaotic counter-flow in a subduction channel, may also be an inherited feature from the rifting history. Within this context, the high-pressure Alpine tectono-metamorphic units were probably detached from the downgoing lithosphere along a hydration front that is typically observed in present-day distal margins.

The relationship between the architecture of the Jurassic rifted margins and the distribution/extent of Alpine metamorphism indicates that the axial zone of the Western Alps, which records multi-stage deformation and high-pressure metamorphism, originated entirely from the European and Adriatic hyper-extended rifted margins. Relative plate motion during Cretaceous–Tertiary inversion was largely accommodated at the transition between hyper-extended domains, floored by extremely thinned crust or hydrated subcontinental mantle, and proximal domains consisting of thicker continental crust. As a result, distal hyper-extended margins were preferentially subducted, whereas the proximal domains underwent relatively minor deformation and metamorphism. The final stage of continent-continent collision was achieved following subduction of the distal European margin, when the European necking zone reached the subduction zone.