Unraveling the crustal structure of hyper-extended rifted margins: the example of the Bernina domain in the Alpine Tethys (SE Switzerland)

Geoffroy Mohn[1], Emmanuel Masini[1], Gianreto Manatschal[1], Marco Beltrando[2], Othmar Müntener[3], Nick Kusznir[4]

[1] CGS-EOST, Université Louis Pasteur, 1 rue Blessig, F-67084 Strasbourg, France

[2] Dipartimento di scienze Mineralogiche e Petrologiche, Università di Torino, Torino 10125, Italy

[3] Institute of Mineralogy and Geochemistry, University of Lausanne, CH 1015 Lausanne, Switzerland

[4] Department of Earth and Ocean Sciences, University of Liverpool, Liverpool, L69, UK

The discovery of exhumed continental mantle and hyper-extended crust devoid of significant normal faulting directly overlain by shallow marine sediments in many present-day distal rifted margins contrasts with the well know tilted block geometry observed at proximal margins. These new observations show that distal margins underwent a completely different spatial and temporal evolution than the adjacent proximal margins. The better understanding of distal margins and the processes that explain extreme crustal thinning and mantle exhumation are not only a major target for the comprehension of rifted margins, but as also for the understanding of internal parts of collisional orogens such as the Alps, because they result from the reactivation and accretion of former distal margins. In order to study extreme crustal thinning and its subsequent reactivation, we initiated a research project in the Bernina/Campo nappes in SE Switzerland and N Italy, where remnants of the transition between the proximal and the distal Adriatic rifted margin is exposed.

The Bernina/Campo nappes preserve a pre-rift crustal section formed by (1) lower and middle crust comprising Permian gabbros and granulites (Sondalo Gabbro), (2) upper crust formed by a poly-metamorphic basement intruded by post Variscan granitoids, and (3) remnants of a sedimentary cover, which comprises a Permo-Triassic pre-rift sequence and Lower to Middle Jurassic syn-rift sequence that are overlain by Upper Jurassic to Lower Cretaceous deep water post-rift sediments. These units preserve the thinning of the continental crust which are characterized by a system of conjugate crustal scale detachment systems along which the middle crust (e.g. Campo/Grosina units) is omitted (necking zone). As a result, upper crustal rocks are juxtaposed against lower crustal and mantle rocks (e.g. Margna shear zone). Locally, these faults reach the surface (e.g. Val dal Fain) and form top-basement detachment faults, which are overlain by extensional allochthons or syn-rift sediments that were onlapped by post-rift.

To conclude, the Bernina domain represents the transition between the distal margin and the proximal margin comparable with the necking zone in present-day magma-poor rifted margins. The results of this study lead to better constraints of the thinning processes of the crust and give access to the deformation of the middle crust during Jurassic rifting. These results have major implications for the thermal evolution and consequently for the rheology and isostasy of the extending lithosphere, enables to better understand the relations between deep crustal and mantle processes and surface processes during Jurassic rifting (180 to 160 Ma) and may help to better constrain the sedimentary evolution observed in the Middle to upper Jurassic sedimentary sequences in the Austroalpine units. Last but not least, this work also has major implications for the interpretation of the locale geology and the interpretation of the Austroalpine units in the Central and Eastern Alps.