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Understanding the tectono-sedimentary record of crustal thinning and mantle exhumation at deep-rifted margins

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Classical rift models are unable to predict the tectono-sedimentary evolution observed at deep water, magma-poor rifted margins. At present the processes controlling crustal thinning and mantle exhumation are not yet understood and little is known about the associated syn-tectonic sedimentary system. This is mainly due to the lack of examples and data from present-day active systems. One of the best natural laboratories to explore the evolution of crustal thinning and mantle exhumation and its related syn-tectonic sedimentary record are the remnants of the ancient Tethys margins exposed in the Lower Austroalpine and South Penninic units in the Alps in SE Switzerland. The reconstructed architecture of the Jurassic rifted margin enables to demonstrate a very contrasting evolution of the proximal and distal margins, the former showing classical fault-bounded rift basins whereas the latter preserving a spectacular rift-related detachment system. The goal of this presentation is to discuss the relation between crustal thinning and mantle exhumation accommodated by detachment systems and the related stratigraphic and sedimentary evolution.

The rift-related detachment system is exposed within two nappes, the Bernina and Err nappes. While in the Bernina nappe syn- and post-rift sediments are only locally preserved onlapping onto a top-basement detachment fault, in the Err nappe a complete syn-rift sedimentary record is preserved and can be mapped over an area of about 50 km2 within the Samedan zone. The syn-rift sedimentary sequence can be subdivided into 4 units, which are in a stratigraphic order from bottom to top the Bardella, the Saluver A, Saluver B, and Saluver C units.

The Bardella unit consists of sedimentary breccias that result from the reworking of the Triassic to Lower Jurassic carbonate platform. This unit is dominated by debris-flow dominated processes which become less mature up-section, interpreted to be related to the onset of the Err detachment leading to the break-up of the Triassic to Early Jurassic pre-rift carbonate platform. The Saluver A unit, consisting of reworked basement rocks, is interpreted to represent the first depositional unit documenting the exhumation at the seafloor and reworking of basement rocks along a top-basement detachment fault, resulting in a new source and the establishment of a siliciclastic sedimentary system. The Saluver B and C units represent the onset and evolution of a more mature siliciclastic turbidite system. The turbidite currents are funneled along complex tectonic inherited structures that connect the source (Bernina) with the basin (most distal Err domain). The interfingering of Saluver A and B units suggests a progressive change from a local tectono-sedimentary system developing into a large-scale axial turbiditic system. The transition between Saluver B to C seems to characterize the progressive migration of tectonic activity into the zone of exhumed continental mantle further outboard and the general decreasing of the sedimentation rate as documented in the upper Saluver C low-energy deposits.

Each of the 4 syn-tectonic sedimentary units document a change in the style of deformation from high-angle normal faulting resulting in the break-up of the pre-rift carbonate platform (e.g Bardella unit), to crustal thinning and exhumation of basement rocks along detachment faults (Saluver A and B units) and the migration of deformation further outboard resulting in a sag type basin (Saluver C unit). Assessing the syn-tectonic sedimentary record of crustal thinning and mantle exhumation is a key to elaborate new predictive genetic models for the evolution of deep, magma-poor rifted margins.