Carnian-Norian tectonics and seawater from Silicka Brezova, Western Carpathians

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After the Middle Triassic extension and the break-up of the Neotethys Ocean intense tectonic characterize the Late Triassic distal carbonate shelf, expressed in facies changes and breccia formation. A first tectonic pulse in the Late Carnian (Tuvalian 1) results in the flooding of the formerly emerged Wetterstein carbonate platform by forming a pelagic plateau, which lasts until the Late Norian (compare Muerzalpen facies of the Northern Calcareous Alps). The overlying Late Triassic sequence is exposed in a system of several quarries and trenches all west of the village Silicka Brezova in the Western Carpathians (Silica nappes). In the Tuvalian 1 and 2 deeper slope deposits of hemipelagic filament limestones with intercalated resediments from the nearby Waxeneck carbonate platform are relatively high in their Li and Br palaeo-seawater ionisation. A higher Li concentration in the Tuvalian 2 may correspond to volcanic activity; as known e.g., in the Buekk Mts. The next tectonic pulse is reflected in a rapid deepening around the Tuvalian 2/3 boundary: On top of an unconformity hemipelagic reddish Hallstatt-like limestones were deposited; they show a rapid decrease in Li and Br concentration. The Late Carnian to Middle Norian time span is characterized by deposition of grey and reddish hemipelagic limestones, still low in Li and Br. Intense tectonic in the Late Norian result in a sedimentary sequence with a general fining upward trend. The Hallstatt Limestones components of Late Carnian to Middle Norian age differ in their litho- and microfacies from the underlying sequence. The provenance area of the clasts might be the outer shelf in the Hallstatt Zone indicating Late Triassic strike-slip induced basin formation as evidenced e.g., in the Karavank Mts. A low NO_3 concentration and a higher F concentration reflect a typical palaeo-seawater of this palaeogeographic realm. The Dachstein carbonate platform progradation is evidenced by shallow-water resediments in the latest Norian hemipelagic limestones, again with an increase in the Li concentration. The tectonic and the known Late Triassic crisis events are reflected in the palaeo-seawater composition.

Petrographic features of chloritoid schist from southeastern slopes of Mt. Medvednica, (Zagorje-Mid-Transdanubian zone, Croatia)

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In the frame of detail mapping of parametamorphic rocks on the southeastern slopes of Mt. Medvednica (Zagorje-Mid-Transdanubian zone, Croatia), samples of the chloritoid schists were analyzed in more detail.
This study is a part of preliminary research that included XRD, XRF, ICP-MS, SEM, electron microprobe and microstructural characterization of chloritoid schists in order to determine their petrography, microstructural features, mineral assemblages, phase composition, whole-rock and mineral chemical composition and morphology of accessory minerals (zircon typology).

The samples can be categorized as chlorite-muscovite-quartz schist, chloritoid-chlorite-quartz-muscovite schist, chlorite-muscovite-quartz-chloritoid schist and interbeds of marble. Accessory minerals in chloritoid schist are tourmaline, zircon and rutil. Microstructural features show two deformational events, the sinmetamorphic and postmetamorphic events. The latter deformational event is recorded in the development of flazer structure, where the mineral grains in cleavages are translated, fractured and rotated.

The whole-rock chemical analyses show high concentrations of SiO_2 (74.79 wt. %), K_2O (2.5 wt. %), Al_2O_3 (13.22 wt. %), and low values of MgO (0.99 wt. %) and CaO (0.08 wt. %).These results indicate that acid rocks could be a possible protolith. The REE distribution normalized to chondrite shows higher LREE to HREE concentrations ((La/Yb)N=5.68, (La/Sm)N=3.05, (Gd/Yb)N=1.21), while the Eu anomaly has a low value (Eu/Eu*=0.7).

Such metamorphic mineral assemblage is characteristic for low-grade metamorphism. The chlorite-chloritoid geothermometer gives metamorphic temperature values of approximately 450°C.

The source rocks of the chloritoid schist are argillaceous sandstones, derived from acid magmatic rocks, interbeded with carbonates. Carbonate interbeds indicate deposition in a marine environment. The morphology of zircons shows that the source for protolith is of granitoid composition, while their weak roundness indicates a short transport.

The role of rift-inherited hyper-extension in Alpine-type orogens

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The Alpine orogen is commonly interpreted as the imbrication of rifted margins and intervening “oceanic” domains. Notably, the understanding of the architecture and evolution of rifted margins underwent a paradigm shift thanks to new high-resolution refraction and reflection seismic imaging method developments combined with the Ocean Drilling Program. Indeed most continental rifted margins show evidence for hyper-extension prior to lithospheric breakup. Hyper-extended domains are characterized by: 1) extremely thin continental crust and exhumed subcontinental mantle extending over hundreds of kilometers, 2) necking zones marking sharp boundaries between little extended crust and hyper-extended < 10km thick crust.

The discovery of hyper-extended domains and necking zones in rifted margins still awaits to be fully integrated in conceptual and numerical models of collisional orogen evolution. This study aims to constrain the extent to which rift-inherited hyper-extension may control the architecture and evolution of Alpine-type orogens.

Based on the available geological and geophysical datasets, the Alpine orogen can be subdivided into external and internal domains. Notably, the external domains formed at the expense of the former proximal rifted margin associated with a poorly extended crust. In contrast, diagnostic elements for hyper-extended domains are being increasingly recognized in the internal domain of the Alpine orogen while the identification of former necking zone remains more problematic. However, based on the available data, we suggest that the transition between the external and the internal domains still preserves the evidence of a former necking zone.

As a result, we propose that the evolution of the Alpine orogen is strongly controlled by rift inheritance. We suggest that subduction is initiated within the hyper-extended domain rather than the oceanic crust. Subduction processes are enhanced by partial serpentinization due to rifting processes. The continental collision is then triggered by the arrival of necking zones at convergent plate margins. Since they mark the boundary between little extended proximal and hyper-extended domains, necking zones act as buttresses initiating the transition from a