Pre-Alpine and Alpine evolution of the Seckau crystalline basement (Seckau mountains, Eastern Alps)

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The massif of the Seckau mountains (Seckauer Tauern) is mainly built up of granitoids, overprinted by Eoalpine (Cretaceous) deformation during nappe stacking and subsequent extension, and greenschist facies metamorphism. Whole rock Rb-Sr age data of ca. 432 Ma and 350 Ma were assumed to indicate the protolith ages (SCHARBERT, 1981). In this study, a suite of granitoids was geochemically analysed by X-ray fluorescence (Bruker Pioneer S4) in order to derive the processes of magmatic evolution and differentiation. In general, three types of magmatites can be distinguished: granites, granodiorites and quartz-monzodiorites. The first two form the majority, whereas the intermediate quartz-monzodiorites are only locally exposed.

Following the A/CNK discrimination diagram a clear distinction between S- and I-Type granitoids can be established. The S- type granites are mainly part of the structurally uppermost sections and are covered by Permian to Lower Triassic metasedimentary sequences of the Rannach Formation.

Within the AFM diagram all granitodis are characterized by a calcalkaline trend. This suggests formation of the melts during a subduction process. Within the R1-R2 digram, the granitoids are related to both pre-plate collision, syn-collision and post-collision uplift settings. We therefore suggest that the granitoids of the eastern Seckau massif are part of an intrusion sequence during distinct stages of a plate tectonic cycle, i.e. from pre- to post collision, and that the related magmas differentiated from intermediate (quartz-monzodiorites) I-type to acidic (granites, granodiorites) S-type.

Biotites separated from the granitoides yield Rb-Sr age data between 83 and 87 Ma, and 80 to 76 Ma. These ages are assumed to represent cooling ages related to the exhumation of the Seckau massif subsequent to Eo-Alpine greenschist facies metamorphism.

SCHARBERT, S. (1981): Untersuchungen zum Alter des Seckauer Kristallins. - Mitt. Ges. Geol. Bergbaustud. Österr., 27: 173-188.

Jurassic and Lower Cretaceous tectonics of the Western Carpathians: coupled vs. uncoupled hinterland shortening and foreland stretching

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During Jurassic and Early Cretaceous, tectonic evolution of the Western Carpathians was governed by two competing, but mutually related processes – hinterland collision and prograding nappe stacking after closure of the Neotethys-related Meliatic oceanic domain, while the external zones underwent lithospheric stretching that graded into opening of the Atlantic-related Penninic oceanic zones. This contribution attempts at interpretation of these processes from the point of view of crust dynamics as revealed by deep-seated structural-metamorphic and surface sedimentary records.

Opening and ensuing spreading of the Meliatic branch of Neotethys was initiated in early Middle Triassic and lasted until Late Triassic (245–210 Ma) while overall distensional tectonic regime acted on its broad northern European passive margin. The geodynamic situation changed by the earliest Jurassic, when this shelf underwent wide rifting during Lias to Middle Dogger with formation of extensional, gradually pelagic basins (200–170 Ma). Contemporaneously, subduction of the Meliatic oceanic lithosphere commenced. These processes were likely triggered by a change in large plate kinematics – SE-ward drift of Africa and Adria with respect to Europe during opening of Central Atlantic. The Western Carpathian orogenic wedge nucleated by accretion of material scraped off the subducted Meliatic crust, accompanied by formation of early melanges rich in ophiolite material. In the Middle Jurassic time, the continuing rifting in distal European foreland resulted in breakup of the South Penninic-Vahic Ocean (ca 170–165 Ma). During the next periods, the Western Carpathian orogen behaved as an autonomous converging system driven by the downgoing Meliatic slab.

The Late Jurassic epoch started with incipient collision after closure of the Meliatic basin and by subsequent overriding of the Carpathian Austroalpine passive margin by the Meliatic accretionary complex, including a blueschist nappe (originally a distal passive margin element). In the peripheral foreland, compressional basins developed sequentially in front of thin-skinned thrust sheets of the later Hronic and Silicic nappe systems, which were filled with synorogenic, partly mass-flow deposits with decreasing amount of ophiolitic material (165–155 Ma). Activity of the pro-wedge slowed down during the latest Jurassic – earliest Cretaceous, while the retro-wedge grew at this time (155–140 Ma). After all the Meliata-related oceanic zones were consumed, thrusting relocated to the pro-wedge again, where the Gemeric basement sheets were stacked above the Veporic basement/cover superunit (140–125 Ma). In a coupled system, the collisional crust thickened considerably, as registered by structural-metamorphic and thermochronological data from the Veporic basement.

Throughout the late Lower Cretaceous, the wedge remained in a contractional regime. After foundation of an intracontinental underthrusting zone between the Fatric and North Veporic zones at ca 110 Ma, the pro-wedge began to grow rapidly by incorporation of the entire Fatric-Tatric crust. This was enabled by thermal softening of the Veporic basement and resulting decoupling of the Neotethyan collisional stack from the lower Fatric-Tatric plate. Subsequently the uplifted plug in the wedge centre – supra-Veporic mountainous area, which supplied the mid-Cretaceous peripheral flysch basins with clastic material (110–95 Ma), collapsed by orogen-parallel extension during the Late Cretaceous (90–70 Ma).

Acknowledgements: The author is thankful to the VEGA Scientific Grant Agency (project 1/0193/13) and to the Slovak Research and Development Agency (SK-AT-0002-12) for the financial support.

Possible amounts of tectonic overpressure in the Adula nappe (Central Alps) derived from a new restoration of the NFP-20 East cross section

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Within the NFP20-East cross section through the Eastern Swiss Alps, the Adula nappe is remarkable for eclogite and garnet peridotite lenses testifying to Late Eocene high- to ultrahigh-pressure metamorphism. The pressure values established for these rocks by petrological methods exceed those of the over- and underlying units and define a gradient spanning from c. 17.5 kbar in the north to c. 30 kbar in the south. The oldest pervasive structures postdating high-pressure metamorphism are related to strong top-to-the-north-northwest shearing ceasing under amphibolite- to higher greenschist-facies conditions. Paradoxically, but similar to other ultrahigh-pressure units in the Alps, these movements were top-to-the-foreland, i.e. thrusting movements associated with decompression. Conventional kinematic reconstructions for the exhumation of the Adula nappe assume that