Significance and Consequences of Cretaceous Convergent Tectonics in the Vepor Unit, West Carpathians

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The Vepor unit composed of the pre-Alpine basement and Late Palaeozoic – Mesozoic cover sequences is one of the major crustal segments incorporated into the Alpine structure of the Central West Carpathians. The basement consolidated during Variscan tectono-metamorphic event consists of high-grade orthogneisses, migmatites and large calc-alkaline intrusive bodies overlying meta-sedimentary rocks, mainly micaschists, paragneisses and amphibolites. The basement rocks together with the sedimentary cover rocks were largely modified during Cretaceous time when several deformation events occurred.

Our field studies revealed existence of four different structural domains throughout the Vepor unit. In northern, southern and eastern domain, we distinguished dominant generally SE dipping cleavage defined by axial planes of isoclinal folds. The cleavage changes its dip from moderate in the North and the South to sub-horizontal in the East. On the contrary central domain of the Vepor unit is characterized by the presence of sub-horizontal mylonitic fabric connected with development of vast mid-crustal shear zone. The mylonitic fabric bears E-W trending stretching lineation which in general dips to the east. The Vepor unit was subsequently affected by oblique convergence with southern Gemer unit (Lexa et al., 2003) responsible for kinking and folding of earlier fabrics in the weaker lithologies preferentially.

In the central domain, our microscale observations of heterogeneously deformed orthogneiss of the shear zone revealed existence of two metamorphic-microstructural zones: the lower grade LT zone in the east and the higher grade HT zone in the west. The microstructure of the LT zone is characterised by the presence of mantle-core microstructure of quartz and quartz fill of K-feldspar fractures whereas quartz porfyroclasts in the HT zone are completely recrystallized and the K-feldspar fractures are filled with mixture of quartz and albite grains. Electron back scatter difraction (EBSD) measurements of quartz crystal preferred orientation (CPO) confirmed operation of dislocation creep using basal, rhomb and prism slip systems. Subgrain rotation recrystallization mechanism is suggested to operate in quartz in both zones with continuous increase of recrystallized grain sizes from 0.062 mm to 0.119 mm towards the west. P-T conditions in both zones were modelled using THERMOCALC (Powell et al., 1998). By plotting the garnet isoplates we obtain 430–460 °C, 0.5–0.7 MPa for the LT zone and 450–480 °C, 0.6–0.8 MPa for the HT zone. The garnets show continuous decrease of manganese content from core to rim which in context of construction of pseudosection corresponds to prograde P-T path and increase of pressure-temperature up to 0.2 MPa and 25 °C.

We consider observed macro-structural pattern in northern, southern and eastern domain together with prograde P-T path obtained in the central domain being consistent with overall convergence of the region leading to the thickening of the Veporic crust. We propose that the dislocation creep dominated localized stretching of the central part of the Vepor unit during Cretaceous orogeny documents orogen parallel extension event triggered by reduction in strength of the thickened quartzo-feldspathic crust in combination with only limited mechanical influence of the lithospheric mantle (Rey et al., 2001).

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Polydeformational-Polymetamorphic Evolution of the Vepor Unit, West Carpathians: Petrological and Microstructural Study

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The Vepor unit composed of pre-Alpine basement and Late Palaeozoic to Mesozoic cover sequences is one of the major crustal segments incorporated into the Alpine structure of the Central West Carpathians. The basement consolidated during Variscan time was together with its sedimentary cover sequences largely modified during Alpine (Cretaceous) tectono-metamorphic event. Because of strong Alpine overprint it was difficult to distinguish structures and mineral assemblages formed during Pre-Alpine tectono-metamorphic processes. Based on detailed field analysis in combination with microstructural and petrological investigation performed mainly on relict garnet and quartz, we were able to recognize deformation effects and estimate PT conditions of Variscan metamorphic event.

Two varieties of basement rocks were selected for this study; the orthogneiss of the Klenovský Vepor and paragneiss of the Trstie Massif. These rocks are located in the central part of the Vepor unit and their superposition (orthogneiss hanging wall and paragneiss footwall) is assumed to be a result of Variscan nappe stacking. In order to estimate P-T conditions of Variscan metamorphism, THERMOCALC program (Powell et al. 1998) in combination with exchange thermometry were used. Construction of pseudosection and its application on relict garnet proved to be a powerful tool in such polymetamorphic terrain. Thus for the petrological modelling and PT estimates of Variscan metamorphism we only needed information on bulk composition of the rock, specification of metamorphic mineral assemblage and knowledge of chemical composition of the relict garnet. Because of high Mn content in old garnet, the pseudosection was constructed in the MnNCKFMASH system. By plotting the garnet isopleths into pseudosection we obtained temperature and pressure of 630–670 °C, 0.6–0.7 MPa for the orthogneiss and 640–690 °C, 0.65–0.8 MPa for the paragneiss. The old garnet reveals retrograde zoning which resulted from decrease of calculated temperature from core to rim of about 50 °C. To estimate PT conditions of Alpine metamorphism, chemical composition forming relict mineral assemblage was extracted from the bulk composition of the rock. Calculated P-T conditions for Alpine metamorphism correspond to 440–490 °C, 0.5–0.8 MPa for the orthogneiss and 540–590 °C, 0.8–1.0 MPa for the paragneiss. This P-T range for Alpine metamorphism was also confirmed by using conventional garnet-biotite thermometry (Kleemann and Reinhardt, 1994) and average P-T program (Powell and Holland, 1988). In contrast to Variscan garnet, the Alpine garnet shows progressive zoning and indicates an increase of pressure and temperature from core to rim up to 0.2 MPa and 50 °C.

Microstructural analysis of quartz both in ortho and paragneiss revealed bimodal character of recrystallized grain sizes suggesting two distinct deformation events. Detailed microscale observations documented the presence of relicts of older quartz microstructure that is locally completely transposed into a new one. The earlier quartz microstructure bears signatures of high temperature deformation, which in agreement with well constrained natural cases (Stipp et al., 2002) suggests recrystallization by migration mechanism at temperatures around 650-700 °C. Crystal preferred orientation of the later quartz microstructure in the orthogneiss was measured using Electron back scatter diffraction (EBSD), which confirmed operation of dislocation creep using basal, rhomb and prism slip systems. Activation of these slip systems correspond to recrystallization by subgrain rotation mechanism at temperatures around 400–500 °C (Stipp et al., 2002).

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The Palaeogene Forearc Basin of the Eastern Alps and Western Carpathians: Subduction Erosion and Basin Evolution

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Scarce Palaeogene sediment remnants in the Eastern Alps and Western Carpathians are interpreted as remains of a continuous forearc basin. New apatite fission track geochronological data corroborate mild Paleocen–Eocene exhumation and relief formation in the Eastern Alps. Palinspastic restoration and nine palaeogeographic maps of the Eastern Alps and Western Carpathians ranging from the Paleocene to the Late Oligocene epoch illustrate west to east migration of subsidence in the forearc basin. Subsidence isochrons indicate that oblique subduction of the European plate below the Adriatic plate was responsible for forearc basin migration with a speed of 8 mm/year. The Periadriatic Lineament was formed due to shearing by oblique subduction. The Neogene to recent Sumatra forearc basin is an analogous feature for the evolution of the East AlpineþWest Carpathian forearc basin.