Subsidence and thermal history of the Variscan orogen and foreland in the Upper Silesian Basin – a model calibrated by vitrinite reflectance

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The Palaeozoic in the eastern part of the Bohemian Massif belongs to the Rhenohercynian Zone of the Variscan orogenic belt. The foreland is built of the crystalline rocks of the Brunovistulian unit of Baltica covered by Devonian to Lower Carboniferous carbonates. The Variscan flysch (Culm) was deposited during the Visean and its present thickness decreases from the West to the East. The Upper Silesian Basin is considered the Variscan foredeep. It is covered by the Miocene Foredeep and partly also by the nappes of the Carpathian–Alpine orogen with opposite vergency.

The sedimentary fill of the Upper Silesian Basin consists of molasse-type siliciclastic sediments with numerous coal beds of Namurian A to Westphalian age. The vitrinite reflectance (Rr) in the Upper Silesian Basin increases with depth from 0.8 to 2.2 % in the Namurian A and up to 5 % in the Devonian to Visean. Regionally, the coal rank at the Carboniferous surface increases from the East to the West. Mathematical modelling is applied to simulate the burial and thermal history and to calculate the diagenesis with depth in selected parts of the basin. The vitrinite reflectance in deep borehole profiles serves as calibration data in the models.

The modelling results suggest less regional variations in palaeo-heat flow in the Upper Silesian Basin than estimated by the earlier authors while significant differences are observed in the amount of the eroded upper part of Palaeozoic section. The maximum calculated burial occurs in the Variscan flysch in the thrust and fold belt in the W. The thickness of the eroded units decreases toward the foreland in the East. Surprisingly, the least thermally mature Palaeozoic rocks are at present deeply buried below the West Carpathian orogenic wedge. This suggests that the Alpine overthrusting did not expose the Palaeozic units to higher temperatures than those experienced during the final phases of the Variscan orogeny.

Two-dimensional model of subsidence and thermal maturation in the West Carpathian fold and thrust belt and foreland, Czech Republic

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The progradation of the Alpine-Carpathian orogeny caused tectonic mobilization of the foreland associated with subsidence and deposition of Late Cretaceous to Miocene sediments on the southern margin of the North European platform. The facial distribution was controlled by the lithosphere flexure, tectonic activity, topography and global sea-level oscillations. The depocentres migrated towards the foreland and the basin fill was gradually detached from the substratum, stacked and thrust over the foreland. In the Early Miocene, the late orogenic and postorogenic foredeep basin formed.

The evolution of sedimentary basins situated on the eastern margin of the Bohemian Massif is simulated using a two-dimensional modelling programme of subsidence, burial and thermal history. Analysis of diagenetic patterns provides a quantitative evaluation of the sedimentary and tectonic burial, uplift and erosion. The autochthonous sedimentary cover of the Platform shows increasing thermal maturity with depth, i.e., with increasing age. Several erosional events removed a considerable amount of sedi-

ments from the top of the Palaeozoic, Jurassic, Paleogene, and partly also the Neogene of the Foredeep.

Different diagenetic pattern is observed in the overthrust. The Magura and Silesian units are significantly more thermally mature than the external Zdanice and Subsilesian units. The marginal foredeep is the least mature. The extent of erosion decreases from the main fold and thrust belt towards the foredeep. Occurrence of the thermal maturity discontinuously increasing upward suggests a deeper burial of the rear units prior to their emplacement on the frontal units and the foreland.

The results of the modeling show a close relationship of the hydrocarbon generation and migration in the region with the final phases of the Alpine orogeny. The platform sediments and the external overthrust units include intervals of the most important source rocks while the thick Carpathian orogenic wedge acts as a seal and load burying the source rocks to thermal conditions favourable to organic maturation and hydrocarbon generation.

A metamorphic core complex in a foreland: news from the Montagne Noire (S-France)

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The mantled gneiss dome of the Montagne Noire is situated in the southern foreland of the Variscan orogen. It is cored by HT/LP gneisses and anatectic granites ("Zone Axiale"), encased by ENE-trending dextral shear zones, and flanked by low- to very low-grade Palaeozoic sediments. These sediments record tectonic stacking of recumbent fold nappes with grossly S-directed tectonic transport (Arthaud 1970). It is generally agreed that the uplift of the Zone Axiale postdates nappe thrusting, and has reduced the metamorphic and tectonic profile on the flanks of the dome. The internal structure of the dome is characterized by ENE-trending folds which deform a pre-existing foliation and metamorphic zonation, and by extensional fabrics with tectonic transport towards the western and eastern terminations of the structure. Isotopic data reveal a polyphase exhumation history spanning c. 327–297 Ma (Matte et al. 1998, Maluski et al. 1991). The geodynamic setting of the gneiss dome is still controversial: uplift of the gneisses has been alternatively explained by diapirism (Faure and Cottereau 1988), extensional collapse of previously thickened crust (Brun and van den Driesche 1994; Echtler and Malavieille 1990), or compressive folding (Arthaud 1970; Matte et al. 1998). We present new tectonic and metamorphic data, which constrain the exhumation mechanism.

In the axial zone, our own observations combined with published data (Matte et al. 1998) suggest that the ENE-trending folds and stretching lineation are cogenetic. NNW/SSE-shortening and ENE-ward extension combine to form a regime of prolate strain, superimposed upon an earlier stage of deformation with planar fabrics (formed during nappe thrusting). Augengneisses with purely prolate strain probably represent portions of rock, which were left undeformed by the first phase, and therefore only record the strain of the second phase.

As revealed by a regional survey of illite crystallinity and conodont alteration index (CAI), metamorphism occurred during the post-nappe thermal regime imposed by the rise of the anatectic gneisses. Close to the Zone Axiale, where peak temperatures were higher, devonian limestones have been deformed into tight, ENE-trending folds. Detailed mapping of key areas has revealed that these folds do not represent the hinges of fold nappes, but, instead, the flanks of metric to kilometric sheath folds. Like in the Zone Axiale, ductile shearing was directed top to the ENE. It appears, that the lower part of the Palaeozoic mantle, at an earlier stage, was part of the uplifted dome (see also Byung–Joo Lee et al. 1988).

As a working hypothesis, we propose that the Zone Axiale was formed in a pull-apart confined by dextral shear zones, which was extended in ENE, and, at the same time, shortened in NNW/SSE. Uplift of the Zone Axiale was probably aided by buoyancy of the felsic core. During progressive uplift and cooling, the rising core contracted into its present contours.

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