Prediction of Thermal Water Discharge Zones on the Basis of Structural-Tectonic and Geophysical Analysis in Relation to the Exploitation in Sokolov Basin: Preliminary Note (Ohře Rift, Bohemian Massif)

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The Sokolov Basin is considered as a part of the structural domain of the Ohře (Eger) Rift, a major tectonosedimentary feature of Central Europe, characterized by a system of Cenozoic sedimentary basins and intense intraplate alkaline volcanism (Kopecký 1978, Sengör 1995, Adamovič and Coubal 1999). Although the Ohře Rift has long been recognized as a part of the Central European Rift System (Ziegler 1990), its structural evolution remain poorly understood.

The Sokolov Basin is also a place of collision between long-term coal mining concerns and spa Karlovy Vary protection concerns. Both the technology and the method of coal mining in Sokolov Basin are strongly limited due to the existence of Karlovy Vary thermal springs resources that have priority importance. Considering that from the structural and geological point of view, the geohydrodynamic systems of these resources form one single structure, extending as far as the SB brown coal deposits, the possibility of natural barrier layers being negatively impacted by human activity (i.e. mining technology in existing protection zones – especially in areas of hydrogeologically active faults and joint systems) is extremely strong (Trčková et al. 2000). This has also become evident recently in the case of uncontrolled opening of some old exit paths (old drills, old mining works, etc.) that had to be solved as emergency or warning states in relation to Karlovy Vary thermal springs.

The Sokolov Basin proper is a bilaterally tectonically limited, transversally asymmetric depression, extending in WSW-ENE direction. In NW it is limited by the Krušné Hory Fault and also characterised by a system of parallel faults (especially the Grasset and Nové Sedlo Faults), forming a significant tectonic zone of lithospheric range (Ziegler 1990). According to Adamovič and Coubal (1999), most of this system's accompanying faults are younger than the main stage of the Ohře Rift volcanic and sedimentary development.

Another significant fault system of the Ohře Rift are the faults running in NNW-SSE to NW-SE direction (in the Sokolov Basin these are faults following the Svatava, Chodov and Karlovy Vary faults). This system is especially intensively developed in the neighbouring Cheb Basin, forming part of Mariánské Lázně tectonic zone (e.g. Špičáková et al. 2000). The analysis of the Ohárecký Rift filling has shown that some of these faults had already been active synsedimentary.

Emphasised in the most recent studies of the Ohře Rift tectonosedimentary development has been the significance of W-E faults that had already been active in the course of sedimentation as extension faults (Rajchl and Uličný 2000).

From the above it follows that the structural development and the current tectonic architecture of the Sokolov Basin, similarly as the entire Ohárecký Rift, have been affected by several basic systems of normal faults, some of which show a less significant strike-slip component. Typical is above all the en-echelon arrangement of faults, virgation of faults, curvature in directional course, but also their listric geometry. Specific deformation conditions occur above all in places of their mutual interference (crossing). To be expected in these anomalous zones is the substitution of classic dislocation zones, accompanied by mylonitisation, by systems of brittle fracture, above all by development of tensile joints. Thus, places of potential outflow of underground or possibly thermal waters due to joint secondary porosity have formed.

One of the basic tasks of our structural-tectonic and paleostress analysis in confrontation with geophysical and hydrogeological prospecting (possibly interpretation and re-interpretation of existing geophysical data) is to tip these tectonically anomalous zones and areas, including their subsequent verification. Apart from the classical methods of terrain structural and paleostress analysis, all mining geological map and data materials, including primary mining documentation, morphotectonic study of digital elevation model have to be analysed. This method is able to significantly contribute to the localisation of dislocation and joint zones as well as other tectonic phenomena, especially when confronted with geophysics.

Using the results of structural-tectonic studies, regional geophysics, as well as hydrogeological indications, the task of geophysical measurements is to: detect and map the existence and detailed course of water-bearing tectonic zones, the course of covered drifts, determine the localisation of trial hydrogeological, relief or drain borings, detect the gradual speed and direction of mineral thermal underground water flow, etc.

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Kinematics of Fold-Thrust and Nappe Deformations in Variscan Accretion Wedge – Moravosilesian Zone, Bohemian Massif

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The Variscan orogenic belt of central Europe represents a complex of crustal blocks accreted to the Laurussian foreland during closure of oceanic domains between Laurussia and Gondwana. The general kinematics of accretion in Saxothuringian and Moldanubian/Lugian zone of the Variscan belt was towards the northwest up to NNE, however presence of Brunovistulian terrane (microcontinent) on the east resulted in more complex and anomalous kinematics and transpressional character of thrusting, especially inside of Variscan sedimentary accretion wedge of Moravosilesian zone. In this presentation we discuss both eastern apical domain of the Moravosilesian zone in flysh foredeep including coal-bearing foreland basin (Upper Silesian Coal Basin) and most inner domains of Silesicum and Lugicum (Orlice-Sněžník Dome), based on comparative complex kinematics and paleostress analysis. One of a fundamental imaginary discrepancies in area under study concerns relation between direction of thrusting inside of most inner Variscan orogeny root zone (Orlice-Sněžník Dome), where top-to-N thrusting is dominant and top-to-E up to SE thrust kinematics, which is evident for all outer domain (Carboniferous flysh and coal-bearing foreland basin) of Variscan sedimentary accretion wedge.

The Variscan metamorphic and deformation evolution of the Orlice-Sněžník Dome indicates significant thickening at ~340 Ma (Steltenpohl et al. 1993), producing especially in the eastern flank of the dome subvertical transpressional shear bands (deformation D_2) indicating dextral transpression (Grygar and Vavro 1995, Štípská et al. 2001), which follow previous early Variscan top-to-NNW shearing (deformation D_1) along subhorizontal shear bands, well preserved in western Orlice flank of the dome. The same D_1 kinematics is well known from the most northern outcrops of Polish part of the Silesian domain (Obertz-Diedicz and Sziepański 1995) and especially also from the norther part of Silesicum.

Transpressional thickening of the inner Lugo-Moldanubian domain of Variscan orogeny initiates and was contemporaneous with grow and sedimentary filling of synorogenic Moravosilesian flysh foredeep. Final crust thickening of internal Variscan orogeny domains resulted in consequent top-to-SE up to E thrusting (deformation phase D_3) inside of sedimentary accretion wedge of Moravosilesian foredeep and foreland basins. Underplated Brunovistulian foreland carried out essential role in character, development and space distribution of regional deformation. A final stage of this deformation phase is related to widely extend dextral transpression along WNW-ESE and NW-SE striking shears zones.

The geometry and direction of thrusting especially along eastern-most apical domain of sedimentary accretion wedge was significantly conditioned by topography and inherited tectonic ramps of underplated Brunovistulian basement. This fact is well demonstrated on the case of Upper Silesian Coal Basin, especially on the Karviná Central Thrust Zone (Grygar et al. 1989, 2003). Progressive development of the prograde deformation inside accretion wedge was conditioned by layer parallel slip and detachment thrusting promoted by high bedding anisotropy of cyclic sediments. The similar role belongs to lithological inhomogeneities (carbonate versus flysh facies, sandstones layers versus coal seams etc.). Slickensides on the bedding planes and intrafoliation fault indicate WNW-ESE up-to NW-SE compression. Recently known easternmost limit of thrust front reaches today post-erosional eastern limit of the Karviná subbasin (part of Upper Silesian Coal Basin – Grygar et al. 1989, 1998, Koníček and Ptáček 1999 etc.). Next progressive stage was represented by tectonic ramping and fault-bend folds structures. Main fold-thrust system is rather uniform from strike point of view (striking NNE-SSW). Dominant asymmetry (vergency) of folding and direction of thrusting is E up to SE-ward. In the