Tectonic Setting of Sokolov Basin in Relation to Prediction of Thermal Water Discharge Zones

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The study area – the western part of the Eger Rift (the Sokolov basin) – belongs to the European Cenozoic Rift System (Kopecký 1978, Sengör 1995, Prodehl et al. 1995, Adamovič and Coubal 1999, Dézès et al. 2004). This system of graben structures and intraplate volcanic fields spreads over a distance of some 1000 km, including the French Massif Central, the Upper Rhine Graben, the Eifel, the North Hessien Depression, the Vogelsberg, the Eger Rift and the Elbe Zone. Graben structures evolved on top of uplifted basement blocks (Variscan massifs); Tertiary and Quaternary volcanism is mainly concentrated on the flanks of these graben structures along boundary faults or on the adjacent uplifted blocks. Dommainly (ultra-) alkaline, but also more evolved, magmas were erupted. The main rifting phase with incipient graben formation and voluminous intraplate alkaline volcanism lasted from about 42 Ma to 9 Ma. A detailed overview of the Cenozoic volcanic activity in the western part of the Bohemian Massif is given by Ulrych et al. (2003). The most recent expressions of magmatic activities within the European Cenozoic Rift System are the CO₂ degassing fields. The isotope (He, C, and N) composition of CO₂-rich gas emanations of mineral springs and mofettes from the western Eger Rift (Weinlich et al. 1999, 2003) gives evidence for the ascent of gases from fluid reservoirs in the European subcontinental mantle.

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 characterized by a system of minor parallel faults (especially the Lipnice, Grasset, Sokolov 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 NW-SE to SE-NW direction (in the Sokolov Basin these are faults following the Svatava, Chodov and Karlovy Vary faults). This system is especially intensively developed in the surrounding Cheb Basin, forming part of Mariánské Lázně tectonic zone (e.g. Špicáková et al. 2000). The analysis of the Ohárecký Rift filling has shown that some of these faults had already been active synsedimentary. In the area of Sokolov basin the Chodov fault zone striking NW-SE belong to this tectonic system. It interfered with SW limit (contact zone) of Variscan Karlovy Vary granite pluton and was reactivated later in post-rift stage.

Emphasized in the most recent studies of the Ohře Rift tectono-sedimentary development has been the significance of W-E faults that had already been active in the course of sedimentation as extensional faults (Rajchl and Ulíčný 2000, Špicáková et al. 2000). From the above it follows that the structural development and the current tectonic architecture of the Sokolov Basin, similarly as to 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, horsetail-like virgation of faults, curvatures in directional course, but also their normal fault listric geometry (see Fig. 1). Specific deformation conditions occur above
all in places of their mutual interference. 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.

In spite of safety measures aimed at stabilising the hydrogeologic situation of gas-cut thermal springs of the Karlovy Vary type in the coal basin basement, situations arise in the Družba and Jiří open-pit mines (Sokolov Basin) during mining which represent uncontrolled interference with the natural regime of these groundwater bases.Especially dangerous are the old mine workings of abandoned deep mines. An example of such situation is the inrush of thermal waters in the Jiří open-pit mine in January 2003, occurring in the wall of abandoned working base, in close vicinity of the Grasset Fault. The inrush was monitored as to its yield and hydrogeochemical composition, before the place of inrush was sealed by inner dump.

In spite of the relatively high resistance of thermal structures to outside impacts, the disturbance of natural steady regime with resulting impact on Karlovy Vary thermal springs may not be ruled out. In such event the restoration of conditions would be most difficult and lengthy, with far-reaching consequences for the spa town Karlovy Vary.

From the viewpoint of geotechnical stability of the seam basement, the most critical situation is in the vicinity of the Grasset and Nové Sedlo faults in Jiří open pit mine (thermal waters uncovered overpressure reaches up to 0.6 MPa).

When studying the hydrogeologic relations between the groundwater basement of the Sokolov coal basin and the Karlovy Vary thermal spring used for balneological purposes, a systematic and complex approach was adopted. Both hydrogeochemical methods and methods of classic drill explorations, analyses of geological and tectonic data, analyses of diverse geophysical methods, and hydrogeological methods were applied. The clarification of hydrogeological and hydraulic relations will help to more effectively protect the natural mineral resources of the spa town Karlovy Vary from potential impacts of brown coal mining.

Acknowledgement

This research is financially supported by the Grant Agency of the Czech Republic (research project No. 105/04/0521)

References


