Regional Impact of Mining Activity to the Groundwater Regime: Example Case Study of the Rosice–Oslavany Coal Mine District, Czech Republic

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Abstract

The Rosice-Oslavany coal mine district is the oldest coal mine district in the Czech Republic. The present time flow conditions are dominantly determined by the old mine galleries and pits. Conceptual numerical groundwater flow model was constructed to specify the changes between the groundwater flow regime at the time before beginning of the mining, as well as the regime at present time, when the mine working is already abandoned. It shows significant influence the mine working has on groundwater circulation.

Key words: Rosice-Oslavany coal mine district, Boskovice Graben, mine water, conceptual model, original and post-mining conditions

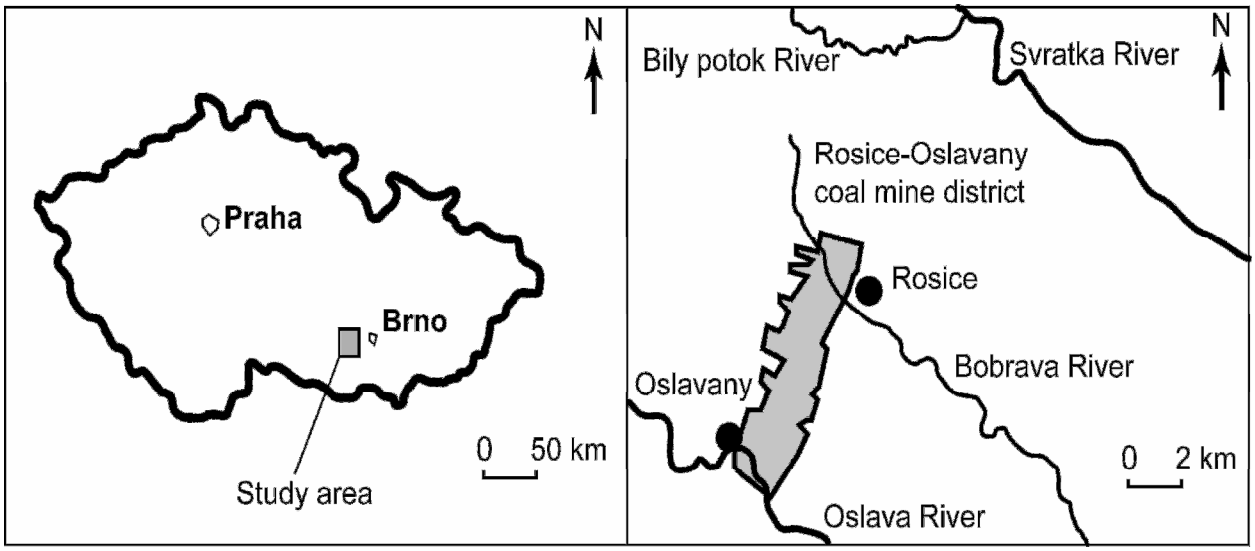
Introduction

The coal mining has a long and famous tradition in the Czech Republic. The area of interest in this example case study is the Rosice-Oslavany coal mine district. Rosice-Oslavany mine is the oldest coalfield in the Czech Republic. The coal mining started already in 1755 and it has been finished in 1992, it lasted almost 240 years. Extensive mining activity caused significant changes in groundwater flow condition. The hydraulic connection of all mines and concentrated dewatering of mine district by the main mine drift caused significant regional changes in groundwater levels and flow conditions. For better understanding how far and in which way the abandoned mine affects the ground water regime, conceptual groundwater flow model was constructed. Two basic stages of groundwater flow in mine district were simulated – the stage preceding mining and the present stage with steady-state conditions after mines were flooded.

Site characterization

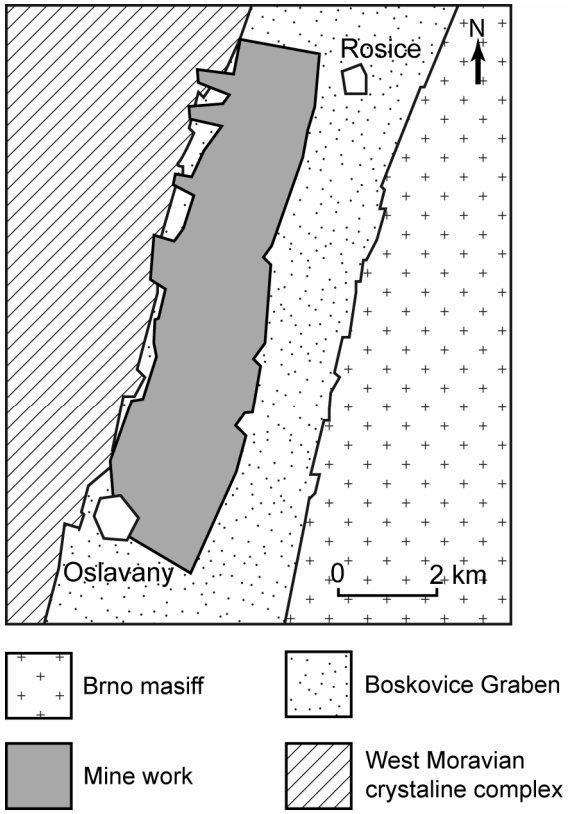
The Rosice-Oslavany coal mine district is situated about 17 km to the southwest from the city of Brno. It extends over the length approximately 10 km between the villages Zastavka and Rosice in the North and Oslavany in the South (fig. 1).

Figure 1 *Position of the Rosice-Oslavany coal mine district*



All of the mine workings, galleries and pits are hydraulically interconnected together at present time, the main drain base of the whole mine work is the Dedicna gallery in Oslavany, about 3 meters above the surface of the Oslava River.

Figure 2 *Main geological units in the study area*



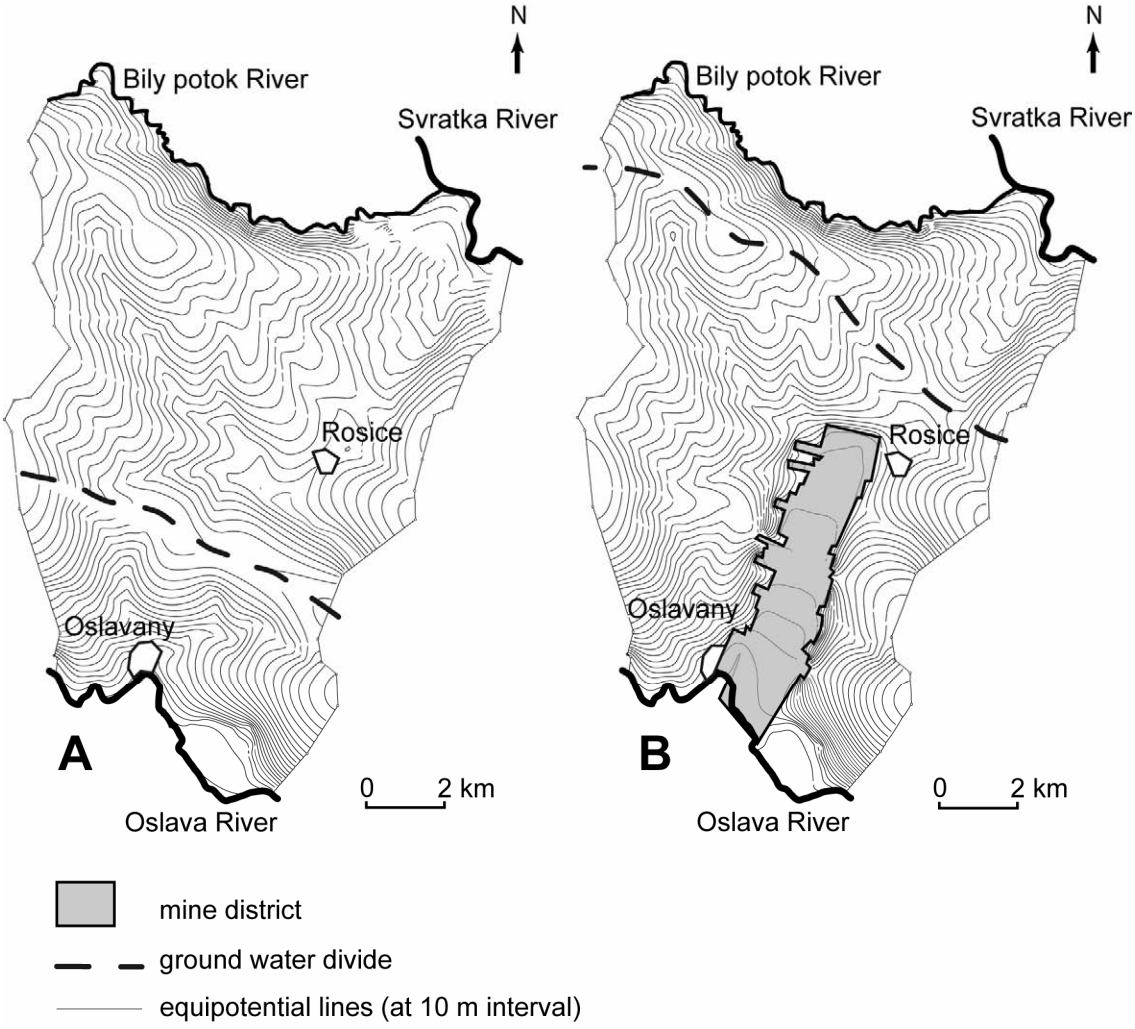
There are three main geological units in the study area (fig. 2). On the West there is the metamorphic West Moravian crystalline complex, where the main lithological types represents the ortho- and paragneiss, amphibolites, granulites and migmatites. On the East of the study area there is a part of the Brno massif unit, with the main lithological types as granodiorites, diorites, ortho- and paragneiss. In the middle between these two complexes lies the Boskovice Graben unit. Boskovice Graben unit is limnic Permo-Carboniferous sedimentary basin. The intrabasinal complex is mostly represented by cyclically arranged fluvial to fluviolacustrine sediments (arkoses, sandstones, siltstones, claystones and micritic carbonates).
In the Rosice-Oslavany coalfield coal was present in three main seams and in several minor seams. Only two seams were usually mineable in the whole extend of the district, other seams were exploited only locally (Pesek 2004).

Model construction
For the construction of the conceptual model the Groundwater Modeling System (shortly GMS) version 5.1. has been used. The computation of the groundwater flow has been accomplished with the MODFLOW 2000 code with LPF (Layer Property Flow) Package. MODFLOW 2000 is cell-centered, 3D, finite difference model that is most widely used for calculation of the steady state or transient saturated flow. The active area of the model is surrounded by the boundary conditions; in this case the boundary conditions are the Oslava River in the South and the Bily potok and Svratka River in the North. In the east and west side the boundary conditions forms natural groundwater divide in the hilly countryside. The model is separated into the 4 layers. Each layer has its specific value of the horizontal and vertical hydraulic conductivity as well as specific value of porosity for each lithological rock type. The first layer matches the quaternary sediments. The second equals the zone of weathered

bedrock. The third and the fourth layers are represented by solid rocks. There are two large bodies of the tertiary sediments, located between the villages Oslavany and Ivancice. These bodies with maximum width of 30 m near Oslavany and 50 m near Ivancice are included into first layer. The area of the model is divided into the individual cells. Size of each cell equals 50 m. The area is divided according to geological situation into three main polygons, the polygon of the West Moravian crystalline complex in the West , the Boskovice Graben polygon in the middle and the Brno massif polygon in the East. The mine district has unique polygon. This polygon was created according to drawing of the mine work in the mining maps and has its own increased values of the hydraulic conductivity and porosity. In the South side of the mine work polygon there is small drainage gallery polygon. The model area has maximum height 540 m above s. l., and minimal 210 m. a.s.l. respectively.
The hydraulic parameters of the mine district polygon have been calibrated according to the observed field values.

Results and discussion
The model shows formation of extensive depression cone caused by dewatering of the mine district. The original ground water flow in the study area was separated by ground water divide in two

Figure 3 *Original (A) and post mining (B) ground water flow conditions*



independent flow domains. As a result of dewatering by drainage gallery and hydraulic interconnection of mines, the ground water divide has moved some 5-7 km to the North. Compared to original period preceding the mining activities, the catchment area of the Oslava River has increased (fig. 3). This is in good agreement with the observations in the field, where quite large infiltration of

the water from the Bobrava River and some other streams on the north was found. The enlargement of the Oslava River catchment could explain higher amount of water in the main mine drift, compared to previous expectations (Vales and Maly 1992).

Conclusion

The conceptual ground water flow model has confirmed significant influence of the large mine work on the ground water circulation. The conditions of the circulation before and after mining are noticeably different, the catchment of the Oslava River has enlarged and the ground water divide has moved to the North. With respect to a mine closing in Czech Republic as well as in Europe, we can consider the area of Rosice coal mine district as an important area for study of the changes in groundwater flow conditions caused by extensive mining activity and subsequently for observation of restoration of the natural environment after its completion.

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