Regional Impact of Mining on Stream Drainage Characteristics in the Rosice – Oslavany Coal Mining District, Czech Republic

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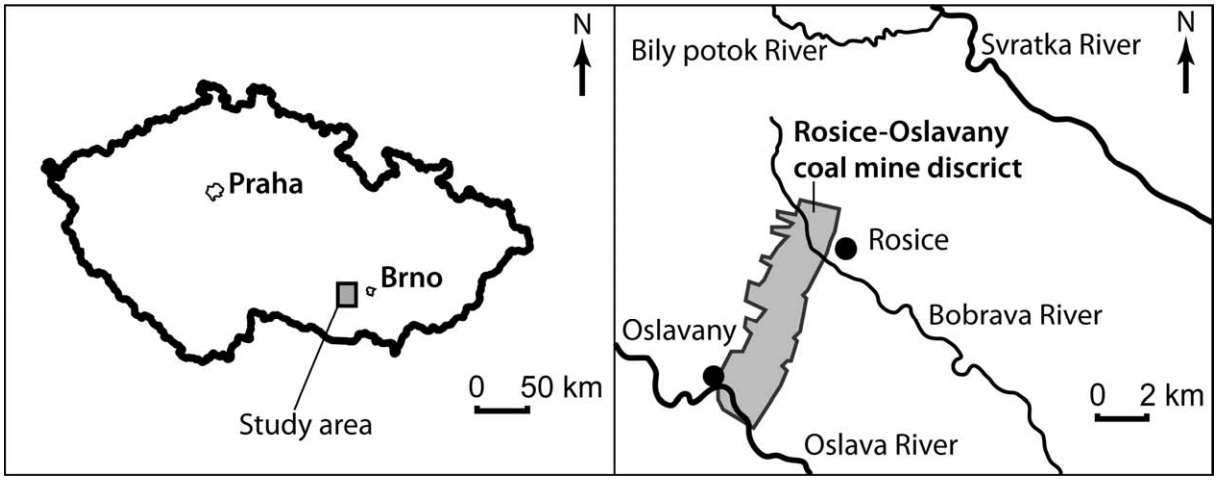
Abstract
The black coal mining in the Rosice – Oslavany mining district was concentrated along the western boundary of the Boskovice Graben, filled by a complex of Upper Carboniferous-Permian sediments. After the mines were flooded in 1998, ground water outflow is concentrated at a single mine drift. The hydraulic connection of mine shafts and drifts with a high permeability zone along the western boundary of the graben allows an inflow of surface water and ground water from alluvial sediments to the deeper rock environment. Based on results of discharge measurements in streams, at least 50% of the ground water leaving the mining district in the main mine adit originates from direct infiltration from streams.

Key words: Rosice – Oslavany mining district, Mine water, Discharge measurement, Loosing streams

Introduction

The Rosice – Oslavany black coal mining district in the Czech Republic was active from 1755 until 1992. The mining district is situated in the Boskovice Graben, which is filled by a complex of Upper Carboniferous-Permian sediments. The mining activities were concentrated along the western boundary of the graben, in a zone about 10 km in length and 2 km in width (fig. 1). During this period, mines with variable depths, from tens of metres up to 1 500 m below surface, were developed. This black coal mining finished in 1992. Controlled flooding of mines continued until 1998, when the present state with relatively steady-state ground water levels was achieved. The ground water outflow from the mining district is concentrated at a single mine adit in Oslavany. The network of mine shafts and drifts is in hydraulic connection all over the mining district; the excavated space represents the most permeable zones in the graben. Previous hydrogeological studies predicted a total inflow of water to the mining district between 20–30 L/s (Vales and Maly 1992). However, a different situation was observed after the mine flooding, when the ground water in the mining district is held at regulated levels. Total outflow from the main mine adit is significantly higher than predicted and varies between 35and80 L/s. Since the inflow of stream water to mines was confirmed in previous studies (Maly 1961), detailed investigation that focussed on the exact determination of inflows from surface water to mines began in 2007.

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



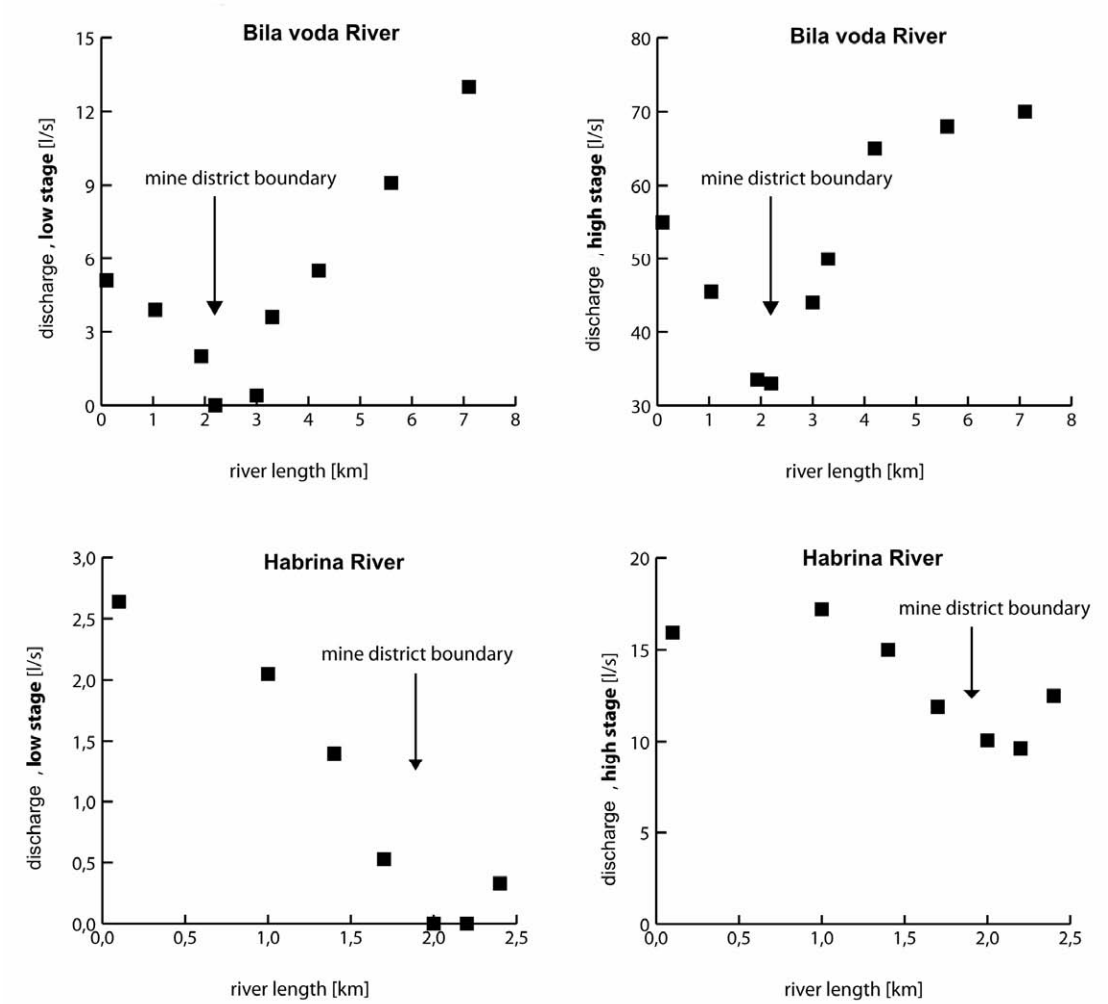
Methods

Detailed measurments of discharge in streams and rivers flowing into the graben was performed. However, the characteristics of stream beds and turbulent flow in the channels precluded the use of weirs or conventional flowmeters for discharge measurement. Tracer tests were performed to determine the discharge values in stream channels. The sudden-injection method (Rantz 1982) with NaCl as a tracer was used. Changes of electrical conductivity values in time were measured at downstream sampling sites. WTW 350i equipment with the TetraCon 325 electrode was used for electrical conductivity measurement. Four cycles of discharge measurement were performed. The cycles represent typical climatic stages – from low stages in dry season at the end of August 2007 to high stages in December 2007, when heavy rainfall occurred.

Results and discussion

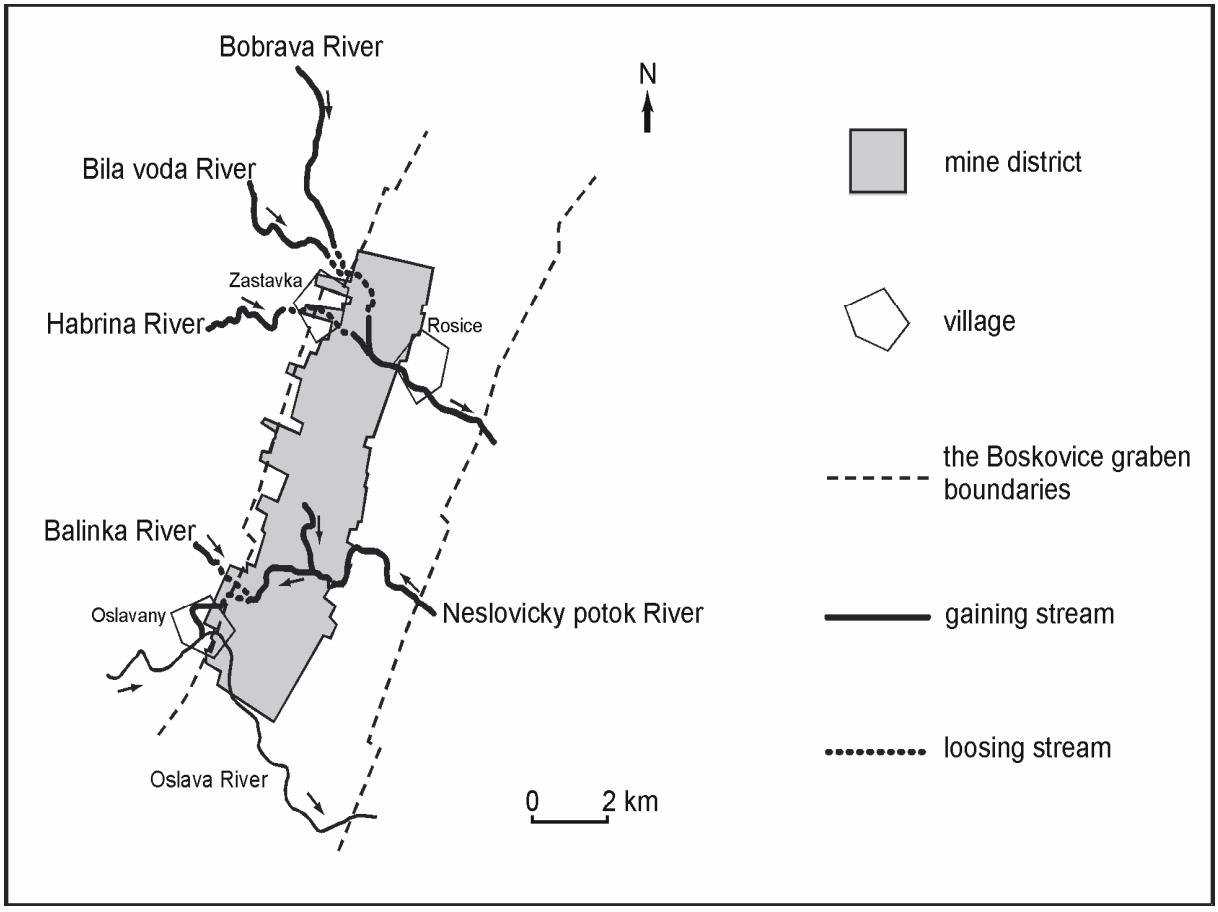
Measurement of discharge in all streams intersecting the western boundary of the Boscovian Graben confirmed loss of water in those streams. The loss of water was determined in all 4 cycles of measurement. During the low stage in August 2007, the total loss of water was observed in all streams flowing to the mining district from the west. The loss of surface water varied between 0.2 and 5 L/s in single streams. During higher stage periods, only declines of discharge values were observed; the loss of water varying between 2 and 22 L/s. The total losses of surface water were from 15 L/s in August 2007 to 42 L/s in December 2007. The changes of stream discharge in the two most important streams intersecting the western boundary of the mining district, the Bila voda River and the Habrina River, are shown in fig. 2.

Figure 2 *Changes in stream discharge in the Bila voda (Bobrava) River and the Habrina River*



Typically, the decline of discharge or total loss of surface water is spatially related only to the western boundary of the Boscovian Graben or to the western part of mining district. The mine shafts and drifts following the mined seams are found at shallow depths along the western boundary of the mining district. Different geological settings of the eastern boundary of the graben prevents infiltration of stream water to the subsurface environment, a similar situation prevailing in the central part of the mining district. The deeper position of mine drifts and continuous presence of Permian, low-permeability units above the mine drifts impede infiltration of ground water from shallow flow to mine works. This results in variability of drainage characteristic of streams along flowpaths. The streams are maintain their gaining characteristic only in the crystalline rocks complex, to the west of the graben as well as in the central and the eastern part of the graben. Close to the western boundary of the graben all streams are loosing streams (fig 3). Zones of rapid streamflow decline are related to the presence of both fault structures in a NNE-SSW direction and outcrops of basal Upper Carboniferous rocks and/or weathered crystalline rocks forming the bedrock, respectively.

Figure 3 *Positions of gaining and loosing sections of streams*



The total amount of water entering the mine environment from the streams and rivers along the western boundary varies from 15 to 40 L/s. Compared to the total discharge of water leaving the flooded mining district from the main mine adit, almost 50% of the mine water comes from losing streams. The difference between expected and actual outflow of mine water from the mining district could be explained by the underestimated impact of hydraulic connection of surface water in streams and mine workings. Dewatering in the mining district increases the hydraulic gradient at the western boundary of the mine workings and enhances the infiltration of surface water from streams.

Conclusions

Hydraulic connection of mine workings, groundwater discharges from the mining district being concentrated at the main mine adit and specific geological setting of the Boscovian graben enables

infiltration of surface water to the mines. Based on stream discharge measurements, about 50% of mine water that discharges in the Rosice – Oslavany coal mining district originates from surface streams. Other important amounts of water may infiltrate to the mines from alluvial sediments close to the zones of stream discharge decline, which is the subject of ongoing research.

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