Groundwater flowing in the forefield of the ČSA mine (North Bohemian Brown Coal Basin in the Czech Republic)

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Abstract Submitted paper describes the simulation of the groundwater flowing in the significant collectors of the interesting area. The interest area is situated to the central part of the North Bohemian Brown Coal Basin in the Czech Republic. There is one of the biggest coal opencast mine called CSA in the Czech Republic. The groundwater flow brings in consequence great stability problem of the upper overburden cuts. We decided to construct the three dimensional geological model and we created a simulation of the groundwater flowing. The submitted paper follow up by the available archival materials, comprehensive processing geology (depositing, lithological characteristics) and hydrogeological conditions. The results of geological and hydrogeological analysis help us to identify the areas that could pose risk for the extraction of mineral resources, particularly of the brown coal.

Key Words brown coal, flowing, groundwater, mining, sediments

Introduction

The North Bohemian Brown Coal Basin is situated in the northern part of the Czech Republic. There is one of the biggest active opencast mine in the Czech Republic, called ČSA. The interesting area is limited in the north by the Krušné hory Mountains, in the west by the mine ČSA. In the south and eastern south is the border creating by the volcanic complex of České středohoří. [1]

The groundwater flow in the quaternary sediments brings in consequence great stability problem of the upper overburden cuts. For the next durability of the CSA mine, is necessary to giving attention to the problems of the quaternary collector. With respect to character and volume of the quaternary sediments in the front zone of the CSA mine, will be the dewatering of the quaternary aquifer the most important thing for the next steps of the mine. [1]

Geological characterization

The contact between the tertiary sediments of the North Bohemian Brown Coal Basin and Krušné hory Mountains creates a very complicated structure. This structure was formed in process of the geological development of the area. The geological structure of the intesting area represents these stratigraphical units: Crystalline complex, Cetraceous Period, Tertiary complex (basin sediments and volcanites) and Quaternary. Maximum attention has been attended to quaternary sediments and the complex of the crystalline.

The Crystaline complex creates the natural massif of the Krušné hory Mountains and the underlay of the sedimentary filling of the brown coal basin. The dominant crystalline rocks are othometamotphits. Orthometamotphit rocks include small-grained, middle grained gneiss and granites. Rigidity of the crystalline rocks is disabled by the processes of alteration in wide area of the Krušné hory Mountains and under the sedimentary filling of the basin. [1,2]

The basin (tertiary) sediments are in the interested area creating by the underlay complex, coal seams and by the upper lay complex.

The underlay complex is representing by the sediments situated directly to the underlay of the coal seams. Stratigraphically is it heterogeneous unit with various sediments of Tertiary complex (clays, sandstones, sands) and Cetraceous sediments (quartzite, sandstones, calcareous clays, marlites, lime stones). The volcanic rocks belong to the underlay complex as well. The volcanic rocks are mainly basalts, phonolites, tuffs. [2]

Coal seam is representing by the xylite-detritic coal. The average thickness is above 25 – 40 m. The average thickness varies about 20—40 m. Nett calorific value varies about 12 – 16 $MJ.kg^{-1}$. The lower part of the coal seam is typical by the variation of the coal and coaly clay. The border with underlay complex is always not sharp in contrast to the border with upper lay complex. [2]

The upper lay complex is characteristic by the group of the clays and sandy clays with variable occurrence of the carbonates. The upperlying sands are mainly evolved in south-eastern part of

the basin. These sands represent deltaic systems of the ancestral streams. The border of association with quaternary sediments is problematic, especially in the immediate vicinity of the mountain slopes. [1,2]

Quaternary sediments represent particularly coarse-grained gravel, sandy gravel and clays with crystalline fragments. Morphology of the quaternary floor is more complicated than roof and in general is falling from the north to the south or southeastern. Quaternary floor creates a lot of depression and elevation. Complicated floor structure is shown on the fig. 1. There is the evident fast rising altitude close to the Krušné hory Mountains.

The thickness of the sediments varies from 0,2 m to 40 m. The changes in thickness are appreciable from the fig. 2 and fig. 3. Rising thickness is characteristic for the area of talus cones of the former tributaries. The talus cones contain mainly coarse grained gravel and fragments of crystalline. The fragments of crystalline can reach the size from 1 – 5 m. The basin part of the Quaternary creates primarily sandy clay.

Hydrological situation

From the hydrological aspects belongs the interested area to the drainage area of the river Bílina. Major part of all surface water is flow directly into the river Bílina or into the sinistral tributaries. The most important surface streams were Albrechtice stream, Černice stream and Jiřetín stream. According to the opencast mining activities, the streams were many times replaced to the new stream channels. There were also a lot of natural ponds in the interesting area. [3]

The interesting area belongs to the transitional region of the middle European climate. The average temperature of the basin region is 8 °C. The annual rainfall summary is reaching the 500 mm in the basin region and 800 mm in the mountains. [1]

Groundwater flowing in the quaternary cover

Quaternary sediments represent the most extensive saturated collector in the interesting area. The saturation depends on the granulity, thickness of the quaternary sediments, the portion of argillaceous component and on the quantity rainfall. Saturation of the sediments is in the linear dependence on the atmospheric precipitation. Level of saturation is, more or less constant. The

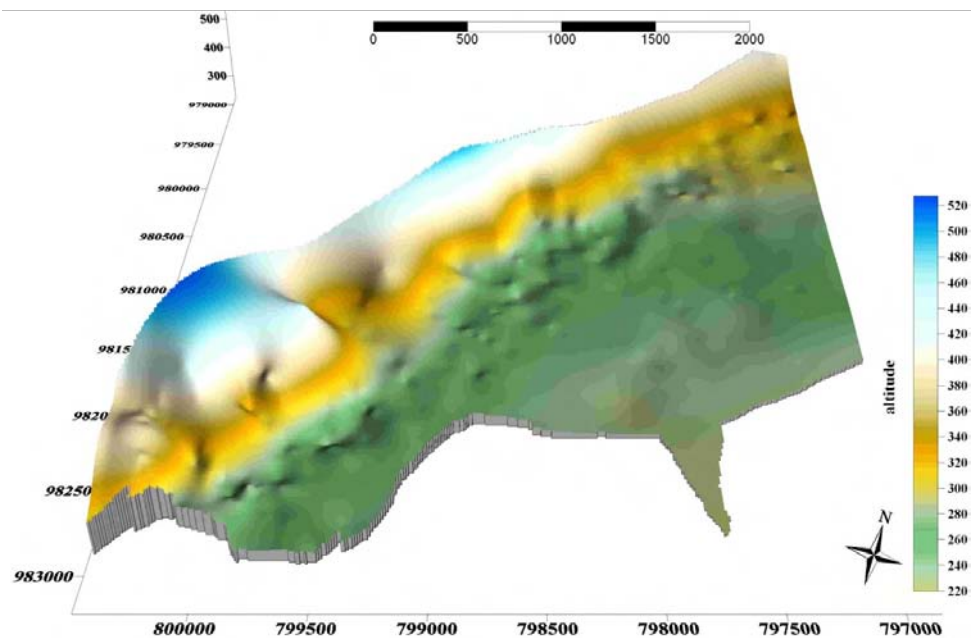

Figure 1 *3D model of the quaternary floor*

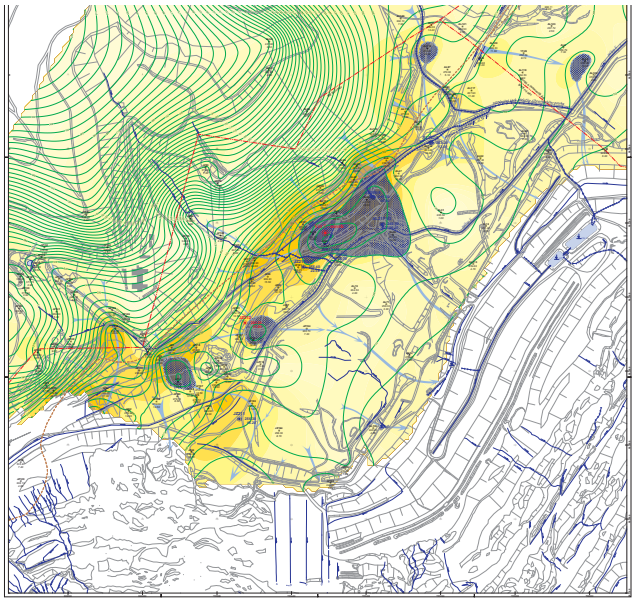

Figure 2 *Groundwater flowing in the forefield of the ČSA mine – western part*

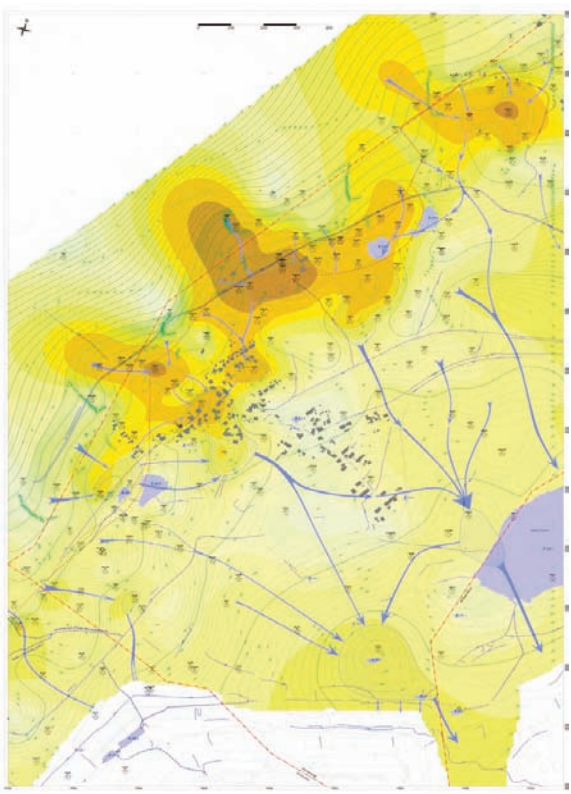

Figure 3 *Groundwater flowing in the forefield of the ČSA mine – eastern part*

saturation level has been confirmed by the measuring of the water level in the hydrogeological objects. The totally dewatering of the quaternary structure is not possible, in the consequence of the quaternary roof configuration and lower coefficient of filtration of some sediment. [2,3]

The system of the groundwater flowing is based on the configuration of quaternary roof, conformability and character of basin sediments and crystalline rocks. Quaternary floor is descending in general from the north to the south or south eastern. Most of the groundwater flow in this direction. [1]

General direction of the groundwater flowing lead from the donation area (slopes and foot of the Krušné hory Mountains) to the basin area. The place of the groundwater outflow is situated close to the upper overburden cuts of the ČSA mine. Hypothetical, in model expressed, directions of the groundwater flowing correspond with the real outflow points on the overburden cuts.

Conclusions

Submitted paper provides the general view on the geological and hydrogeological situation of the main aquifer collectors in the area of interest. The main determining collectors are quaternary and crystalline collector. Both collectors are very complicated structures. Deposition of all quaternary sediments has erosive character. The border between Quaternary and Crystalline or Tertiary in sandy progression is very hardly specifiable. Quaternary sediments create big rugged bodies close to the mountains roof. Segmentation of the bodies is, more evident in the quaternary sediment floor.

System of the groundwater flowing is affected by the configuration of the quaternary floor, deposition and character of the basin sediments and crystalline rocks. Donation area corresponds with the mountains slopes and inflows of the groundwater are negotiating by the disrupted crystalline roof with quaternary sediments.

For the mountain slopes is typical dynamical regime of the groundwater flowing with successive rising and falling of the water level. Water level movement is depending on the atmospheric precipitation. The effect of the groundwater to the slope stability is important part of the stability analysis. The important part of the control observation system is the monitoring of the changes of water level in the hydrogeological objects.

For the next durability of the CSA mine, is necessary to giving attention to the problems of the quaternary collector. With respect to character and volume of the quaternary sediments in the front zone of the CSA mine, will be the dewatering of the quaternary aquifer the most important thing for the next steps of the mine.

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