GROUND WATER HAZARD OF COAL EXTRACTION FROM MARLSTONE BASINS DUE TO SURROUNDING KARST

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ABSTRACT

The majority of Yugoslav brown coal deposits is developed in Tertiary basins with all types of marlstones as predominant sediments. Although marlstones are generaly low permeable and coal extraction from hydrogeological point of view is not difficult, when they are surrounded with karst it becomes extremely different, sometimes with katastrophic consequences. In last few years two coal mines with similar geological conditions "survived" violent ground water attack - "Bogovina" in East Serbia Carpathians, and "Štavalj" in Inner Dinarides, both developed in Tertiary coal-bearing marlstones basins. Hydrogeology of the basins and conditions that caused these accidents, as well as possible future prevention, are described.

HYDROGEOLOGY OF BOGOVINA BASIN AND SURROUNDING KARST

Bogovina brown coal basin is located on southeast limb of Kučaj anticline (East Serbia Carpathians) and developed in Oligocene sediments, predominantly marlstones. The basin is separated from the intensively karstified Mesozoik carbonates by thin (up to 25 m) barrier of Cretaceous sandstone (Fig.1). Although Kučaj karst is very rich with groundwater, including all karst phenomena among which Bogovina cave (one of the longest in Serbia) distinguishes, the mine has been operated without serious ground water difficulties since 1904. Hydrogeological research in seventies showed impermeable function of thin sandstone bed and karst ground water flow directions. The main discharge point of South Kučaj karst aquifer, Mrljiš spring, also drains Bogovina cave sinking waters and its catchment. On the basis of dye tests Filipović at al. (1976) concluded that, in period of high ground water levels, the flow is partly directed to the northwest intermittent spring Fundonj, but never to the mine works. So, the only reason left for the increasing

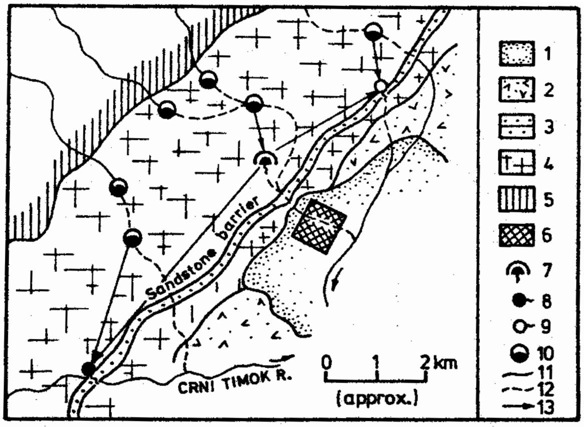

Fig.1 Hydrogeological sketch map of Bogovina coal basin. 1-Oligocene coal-bearing sediments, 2-tuffaceous rocks and andesite of Cretaceous age, 3-Cretaceous sandstone, 4-Mesozoik carbonates, 5-Paleozoik shales, 6-mine area, 7-cave with sinking water, 8-constant karstic spring, 9-intermitent spring, 10-ponor, 11-perennial stream, 12-intermitent stream, 13-proved and assumed underground connection.

ground water inflow into mine works after heavy precipitation and snowmelt, was infiltration of intermitent Bogovina river waters. During the regulation of the river, in its marlstone bed was discovered large opened fissures very similar to karst caverns, up to 20 cm wide.
After the regulation and slandering of the river bed with rubber plates, average amount of pumped mine waters decreased below ten liters per second. The problem seemed to be solved.

The flood causes

After extremely high precipitation and snowmelt in spring of 1986, in two days the mine was completely flooded. Two pumping systems was not sufficient to prevent accident, mainly because their low capacity projected according to former ascertainment about hydrogeological hazard. Regulated bed of the Bogovina also couldn't receive torrent high exceeding probability of ten thousand years return period, and overflow caused forming of lake with depth up to 8 meters. The probable "screenplay"of the flood is shown on the figure 2.
Rapid increasing of ground water level in the hinterland resulted in karst aquifer overflow over the sandstone barrier, marked by emergence of numerous springs, and infiltration under the high pressure into the mine works.
Inundation of Bogovina river was the "final stroke".

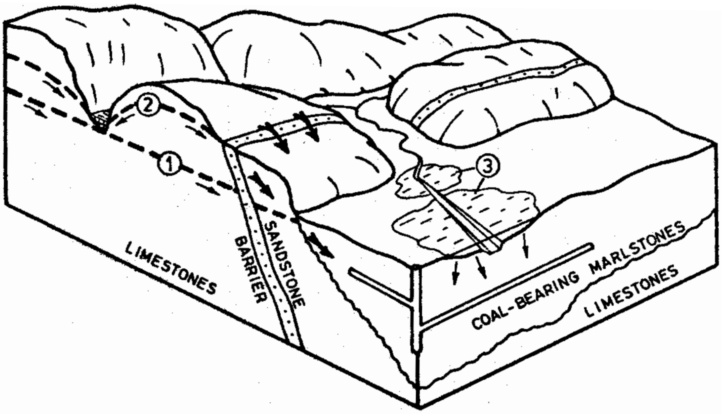

Fig.2 Schematic block-diagram of the Bogovina mine flood. 1-karst ground water level before the flood, 2-karst ground water level during the flood, 3-lakes formed by the Bogovina inundation.

HYDROGEOLOGY OF ŠTAVALJ BASIN AND SURROUNDING KARST

Štavalj lignite-brown coal mine is located in the Ophiolite Belt of the Inner Dinarides, and developed in Miocene marlstone-like sediments, completely surrounded with Triassic limestones (fig.3). Average amount of pumped mine water is 3 m^3/min, which means that it can exceed 10 m^3/min, and every ton of coal is weighted with 40 m^3 of water. These conditions show that fight with groundwater is "normal" stage in the mine operation. Nevertheless, similar accident (but with smaller consequences) happened in 1985 when new underground work cut large regional fault which was connection with flooded old mine works, as well as with north karst aquifer.
Although marlstones are intensively cracked and filled with water (sometimes even with artesian springs), possibilities of draining the mine by drilled wells are small - very low specific capacity of wells is mainly below 0.1 l/s/m . Total yield of wells rarely exceedes ten liters per second.

Possible future mine drainage

For inefficiency of drainage wells and irrational construction of brim grout curtain (having also in mind flow under the pressure through marlstones), solution presented on figure 4 seem to be most acceptable. The primary function of drainage gallery will be lowering of karst ground water level and thus decreasing of inflow under the pressure into marlstone aquifer. Together with drainage wells in the mine area it should result in much more safer coal exploitation.

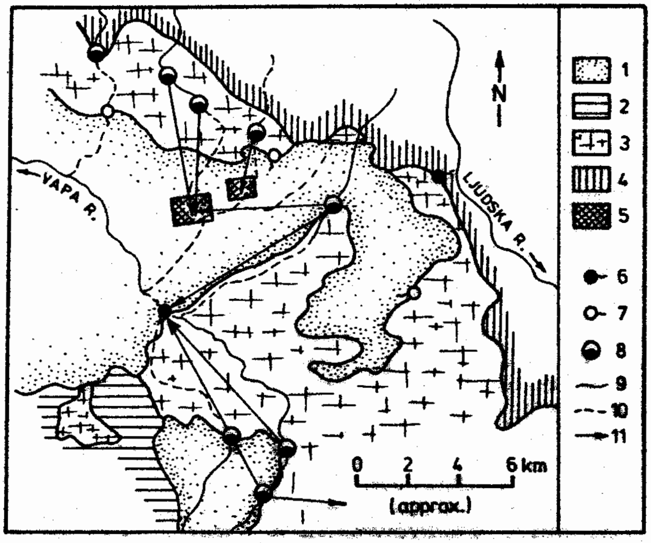

Fig.3 Hydrogeological sketch map of Štavalj coal basin. 1-Miocene coal-bearing sediments, 2-Jurassic Diabase-Chert Formation, 3-Triassic limestones, 4-Paleozoik shales, 5-mine area, 6-constant large karstic spring, 7-intermitent spring, 8-ponor, 9-perennial stream, 10-intermitent stream, 11-proved and assumed underground connection.

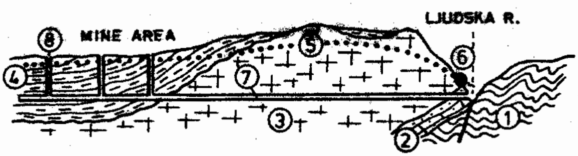

Fig.4 Schematic presentation of possible drainage of Štavalj coal mine. 1-Paleozoik shales, 2-Lower Triassic sandstone and sandy limestone, 3-Middle Triassic karstified limestones, 4-Miocene marlstones, 5-karst ground water level in present conditions, 6-large karstic spring, 7-drainage gallery, 8-drainage well.

CONCLUSION

Coal extraction from marlstone basins surrounded with karst aquifers, especially in intensively tectonized orogene belts and climate with possibility of high intensity of precipitation, is always a hazard. Described examples show that complex hydrogeological researches in these cases are essential, and costs of proper drainage systems in last consequence negligible.

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