FORECASTED CHANGES IN HYDROGEOLOGIC CONDITIONS AT THE LUBLIN COAL BASIN.

Marek Rogoż, D.hab.Sc.,Eng.
Kazimierz Zarębski , M.Sc.,Eng.
Central Mining Institute, Katowice

ABSTRACT

The Carboniferous formations extending within the Lublin Coal Basin Area are overlaid directly with the Jurassic deposits which contain fissure waters occuring under a high hydrostatic pressure. These waters create hazard for excavations being run at the roof portions of the Carboniferous formations. The paper presents hitherto occuring unintended drainage of this water - bearing horizon as well as the planned drainage targeted toward lowering the water pressure whereby the hazard to the mining operations could be diminished. In the further part of the paper the changes anticipated in the Quaternary - Upper Cretaceous water - bearing horizon resulting from post - mining subsidence are discussed.

1. Outline of hydrogeologic conditions

Three water - bearing horizons occur at the Lublin Coal Basin, viz. the Quaternary - Upper Cretaceous, Albian - Jurassic and Carboniferous ones. The Albian - Jurassic horizon is markedly watered and it contains fissures filled with water pressurized up to 6 MPa. This horizon creates a water hazard for the shafts being sunk and for other mining activities carried out in Carboniferous formations. Which is why the hydrogeologic problems at the Lublin Coal Basin are of significant importance for the development of coal mining in this region.

The watering of the Quaternary - Upper Cretaceous horizon over the Central Coal Basin (CCB) area is connected with the strata of Quaternary sands which fills the irregularities of the karstified bed of the Upper Cretaceous formations. This horizon is supplied with water from the lakes and numerous small water courses of the Łęczyńsko-Włodawski Lake District. The water-supply area is drained by larger affluents of Wieprz River, i.e. by Mogielnica, Swinka and Piwonia Rivers. The water table level is situated at the depth ranging from 2-5 m in the gro-

und depressions to a dozen or so m over the uplifted area at the southern part of the CCB. Between the Swinka River Valley and the Lake District a reasonably uniform sand strata occur whereas the remaining part of the area exhibits the inserts of boulder clay and oozes of various origin which provide for local insulation and surface tension of the water table at the first water-bearing horizon. Of a similar range are the Tertiary clay strata having several metres in depth and forming a compact overlay at the Wesołówka-Brzeziny region and occuring in patches over the CCB area.

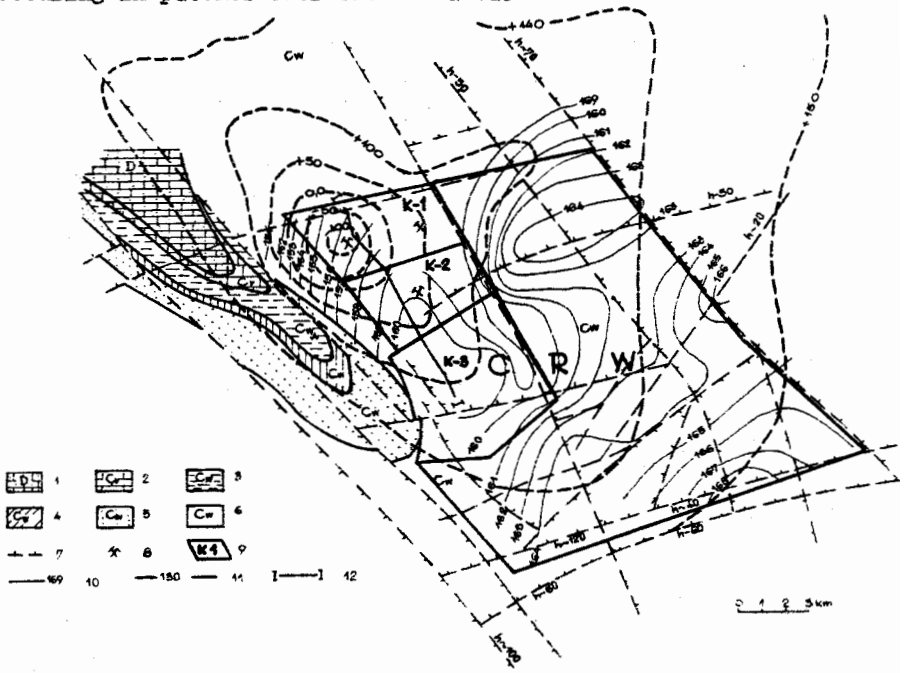

Fig.1
Map of piezometric pressures of the water-bearing horizon of Jurassic rock at the Central Coal Region of the Lublin Coal Basin.
1- Devonian and Carboniferous formations, 2- visenian formations, 3- Komorowo strata, 4- Bużanskie strata, 5- Kumowskie strata, 6- Lublin strata, 7- faults (geologic situation after J.Porzycki), 8- shafts of K-1 mines, 9- mining regions, 10- lines of equal piezometric pressure (meters above sea level) of the Jurassic water bearing horizon under undisturbed water conditions (status before 1978), 11- lines of equal piezometric pressure (meters above sea level) of the Jurassic water bearing horizon under mining drainage conditions (as of II nd quarter of 1986), 12- hydrogeologic profile line I-I.

The Cretaceous formations strata deposited at the depth of 550-620 m show the water - bearing capacity in the roof part down to 150-200 m in depth. In this case an evident relationship can be observed between the watering and the lithologic formations showing a higher content of $CaCO_3$ (compact limestone). Hydraulic limestone Mastrycht marls as well as silt inserts of centimetre size make an insulation reducing the exchange of water through the Cretacenous rock bed. More distinct symptoms of watering reoccur as high as a dozen or so metres above the Albian formations.

The water of Albian-Jurassic horizon are of fissure-layer nature (Albian and Middle-Jurassic sandstone, Middle-Jurassic limestone). These strata are supplied from the area situated outside the range of Mastrycht and outside the Central Coal Basin, where the Cretaceous formation's depth is already smaller (300-400 m). The investigation carried out at the Orzechów-Sawin area has shown the existence of hydraulic communication between the first and second water-bearing horizon. Therefore as the supply zone of the Albian-Jurassic horizon the area situated between the Bug River valley and the Cretaceous formation isopaque of 400 m should be considered.

The Carboniferous formations represented by the Lublin strata exhibit a poor watering in their roof portion at the contact with Jurassic formations and in their floor portion at the contact with Namurian formations. In the central part of the profile of these strata only some thicker banks of sandstone and some coal beds show weak watering.

2. Factors decisive for changes in hydrologic conditions.

The mining activities influencing the changes in hydrogeologic conditions at the Lublin Coal Basin assume the following course:
- at the first stage of mine construction: dewatering of the Albian-Jurassic water-bearing horizon through the shafts frequently having leaky lining as well as developing the excavations into the deeper portions of the bed characterized by a weak watering,
- at the second stage of mine construction: planned depressuring of water at the Albian-Jurassic water-bearing horizon and the development of winning in the roof portion of the bed hydraulically communicating with the lowermost levels of the Jurassic water-bearing horizon.

The course the changes in hydrogeologic conditions follow will be largely dependent upon hydrogeologic parameters of the individual water-bearing layers as well as upon the strength characteristics of the rock-mass. Of particular importance will be:
- reserves and water permeability of the water-bearing layers and hydrostatic pressure of water contained therein,
- water-circulation paths and hydraulic communications between the individual water-bearing layers both those existing and those likely to occur in future due to post-mining deformations,

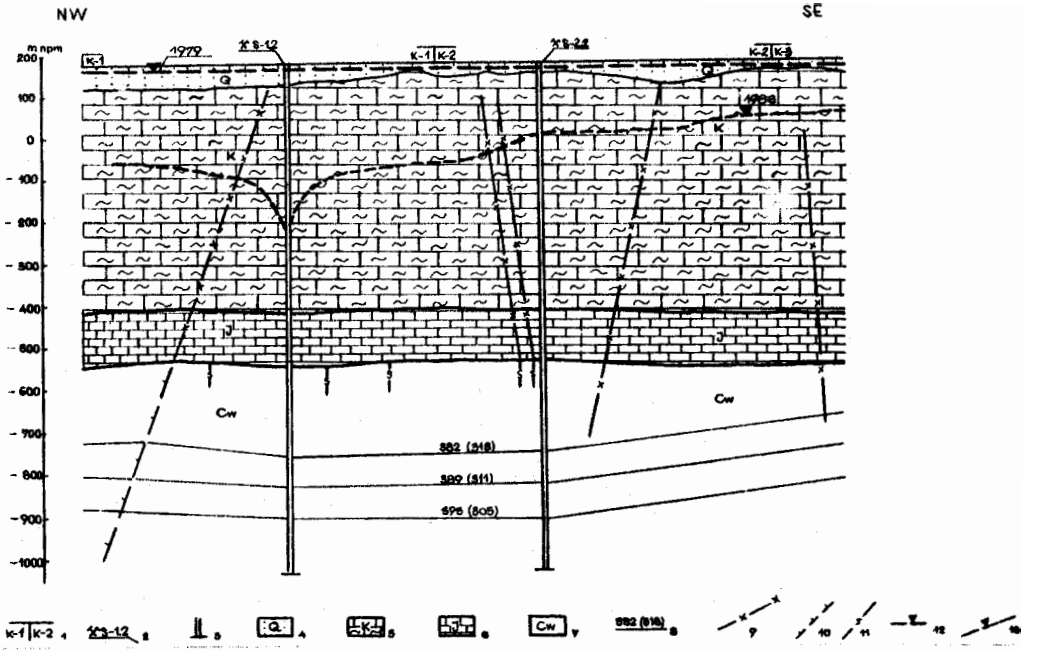

Fig.2. Hydrogeologic profile I–I
1– Mining region boundaries, 2– Mining shafts, 3– Bore holes, 4– Quaternary formations, 5– Cretaceous formations, 6– Jurassic formations, 7– Carboniferous formations, Lublin strata, 8– Coal beds and their identification, 9– Faults revealed by geothermic investigations, 10– Faults revealed by C–1 category investigations, 11– Faults revealed by seismic investigations, 12– Piezometric pressure of the Jurassic water-bearing complex under undisturbed water conditions (before 1978) 13– Piezometric pressure of the Jurassic water-bearing complex under mining drainage conditions (as of II nd quarter, 1986).

- strength and rheologic properties of the rock-mass decisive for the opening or closing of water-permeable fissures.

3. Hitherto existing drainage of the Albian-Jurassic water-bearing floor.

The present water inflow to the excavations at K-1 mine at Bogdanka is about 6,5 m^3/min of which 3,5 m^3/min is attributable to the inflow from the Albian-Jurassic water-bearing floor penetrating the shafts through their leaky lining.

The drainage of Albian-Jurassic floor through the shafts as of the year 1978 resulted in the formation of the area characterized by lowered piezometric pressure (Fig.1 and 2). The main shafts of K-1 mine at Bogdanka are situated at the center of the depression cone whose depth is much over 300m in the Jurassic formations and a little less in the Albian one. According to the observations carried out at numerous piezometer gauge points the range of the depression cone exceeds 20 km in the Jurassic system and, most probably, approaches 2o km at the Albian system. A hydraulic resistance in vertical direction was observed in the water seepage between the most strongly watered dolomite and sandstone of the Middle Jurassic rock and fine sand and sandstone of Albian formations.

The dewatering of water-bearing layers of Jurassic and Albian formations results in the occurence of a vast subsiding trough at the surface, the depth of the trough being about 100 mm at the main shafts of K-1 mine.

4. Planned drainage of the Albian-Jurassic water-bearing horizon

The present concept concerning the dewatering of the Albian-Jurassic water-bearing horizon has been prepared to suit the geologic and mining conditions and the technical possibilities of the first mines K-1 and K-2. Establishment of three drainage centers is foreseen, located at K-1 mine shafts at Bogdanka and Nadrybie and K-2 mine shafts at Stefanów. In each of the centres the entries will be made from the shafts and short headings in the central part of Jurassic formations exhibiting the least watering, whereupon an adequate number of inclined draining holes reaching down toward the most strongly watered Jurassic floor layers will be drilled therefrom. Each drainage centre will be provided with water galleries and pumping systems enabling water to be evacuated at a rate of about 10 m^3/min. An alternative solution provides for the drifting of the gallery in the Cretaneous rock to connect the shafts at Nadrybie and Stefanów, followed by the drilling of drainage holes reaching down to the Jurassic rock.
The first operations aimed at the starting of controlled drainage of the Jurassic rock were commenced at Nadrybie this year. The entries and two short headings were made in one of the shafts at the central part of the Jurassic rock. Further preparatory wark is continued, and a systematic drainage is expected to be started still this year.

Fig 3 shows a forecasted lay-out of the isolines of the depression surface of the Albian-Jurassic water-bearing horizon after three years of controlled drainage. Three local depression cones are distinctly marked around the drainage centres. These cones are connected with one another to form a common regional depression sink. Similar forecasts were worked out to show the status after the six-year and ten-year drainage period. These forecasts are of an approximate nature only since their preparation has been based on the assumption that the water-bearing layers of the Jurassic formations are homogenous, averaging values of hydrogeologic parameters were used and a specific time-schedule including the commencement of drainage and the development of its yield was assumed for each centre. This - schedule is not likely to be met due to mining reasons.

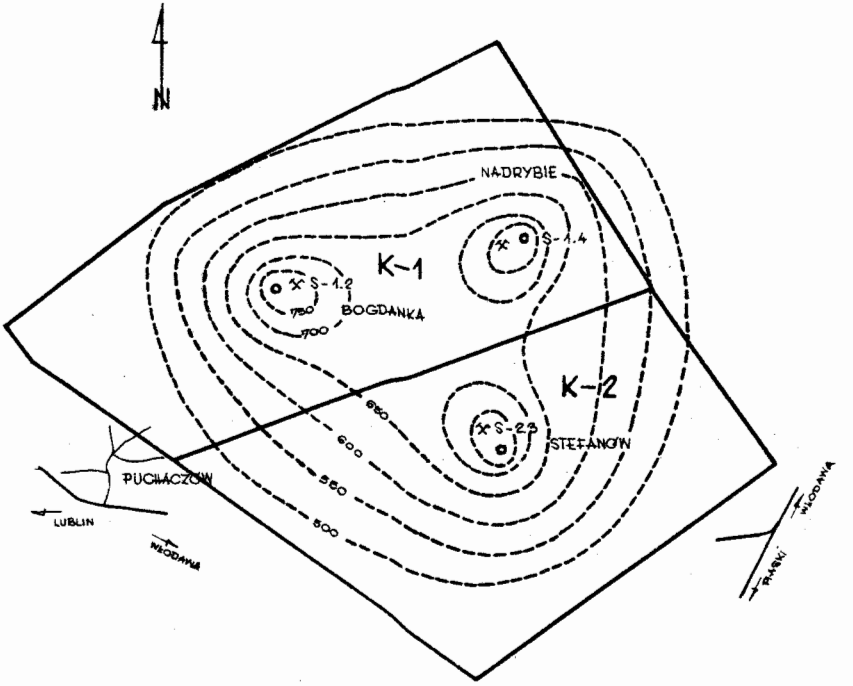

Fig.3. Forecasted lines of equal depression of the Jurassic water-bearing horizon within K-1 and K-2 mine areas at the Lublin Coal Basin. The status corresponds to three-year period after the depressuring has commenced.

5. Forecasted changes in the Quaternary - Upper Cretaceous water-bearing floor.

The longwall system with caving being applied now and planned to be continued in future will result in the formation of subsidence troughs up to several metres in depth at the above mentioned territory. The mining progress will intensify the deformations of rock-mass, destructing the structure and continuity of the Carboniferous overburden layers. Post-mining deformations started to appear after the commissioning of the first longwall in 1982. They resulted in a local drop in pressure of Jurassic waters amounting to about 0.6 MPa in relation to the depression sink surface as well as a local ground subsidence centre.

Changes in water conditions on the surface and at the first water-bearing level will depend largely upon the primary water conditions. North of the Swinka River valley and in the Mogielnica River preglacial valley the water table at the first water-bearing horizon is situated shallow under the site surface. Due to post-mining subsidence floodings and swamps are expected to appear there. Any counteraction will call for complex hydrotechnical operations. In the southern part of the Central Coal Basin where upland prevails the water table is generally situated at a lower depth and therefore it is only expected to change its relative height as compared with the subsiding site surface. In the long term, however, the ground water chemistry may be changed, river beds may get damaged, longitudinal profiles of rivers may be changed, the erosion of river bad bottoms may increase and new water-swelling sills may appear. In general the disturbances in the existing hydrological balance are to be expected.

It is not unlikely that the formation of a large depression at the Albian-Jurassic water-bearing horizon will open certain water-migration paths from the Quaternary - Upper Cretaceous horizon. Some conditions favourable for such a migration have been shown by geothermic investigations conducted in the bore-holes which revealed considerable anomalies in the distribution of temperature in the Cretaceous formations. On the other hand, however the silty-marlaceous nature and a large thickness of the Cretaceous formations separating the two water-bearing horizons from each other seems to contradict such a possibility. Thus, any possible migration of water from the first water-bearing horizon to the second one may be very small and be of local nature only.

6. Summary

The development of mining in the Lublin Coal Basin and particularly in the roof portion of coal bed strata will be accompanied by an intensive drainage of the Albian-Jurassic water-bearing horizon. As far as hydrogeologic conditions of the

Basin are concerned however, this drainage will not cause any principal changes in the resources of the Quaternary - Upper Cretaceous horizon. The changes in ground water level will be connected mainly with the post-mining deformations of site surface.

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