COEXISTENCE OF THE COAL MINING AND THE MINERAL WATER EXPLOITATION IN THE OSTRAVA-KARVINÁ MINING DISTRICT

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ABSTRACT

Some aquifers of the Tertiary cover in the Ostrava-Karviná mining district contain water with increased contents of iodide and bromide. The water is exploited for medical purposes in the spa Karviná-Darkov.

A substitute new locality for the spa had to be searched for because of a deteoration of a life - environment in Karviná-Darkov is inevitable in near future owing to a development of a mining activity there.

A problem of coexistence with a coal mining had to be solved for the new locality Polanka on the Odra, too. Dynamic effects of an undermining represent the primary risk for the regime of aquifers that are the object of interest there.

It was established both the water exploitation for medical purposes and the subjacent coal mining are admissable in the area provided the time and space coordination between the both activities is secured.

An occurrence of mineral water with significant concentrations of iodide and bromide is bound on some aquifers in an overburden of the Carboniferous massif in the Ostrava-Karviná mining district. This type of water has been exploited for medical purposes in the Karviná-Darkov spa for nearly houndred years. A large deteoration of a life environment of the spa owing to the development of coal mining is inevitable in near future.

A suitable new locality had to be searched for in the region to keep the tradition of the spa which is exceptional in Czechoslovakia as regards the type of water. A security of the new spa from an influence of mining was difficult matter of course.

Tertiary aquifers of a regional extent with the best parameters have been negatively affected by a long-time spontaneous drainage to coal mines. Therefore the hydrogeological survey for the new spa had to be oriented on the Lower Badenian pelitic facies.

The Lower Badenian pelitic facies represents the main mass of a filling of depressions of the Carboniferous relief in the region. Lower Badenian basal clastics are interposed between the two units apart from slopes of depressions. Carpathian nappes touch the area from SE.

The flat-lying Pelitic facies consists predominantly of marine clays that are interbedded by lenticular laminas and thin layers of low-permeability stray sands /sometimes slightly cemented/. The indicies of a higher local content of a water-bearing sandy lamination was an important factor for picking out the Polanka on the Odra locality for a detail hydrogeological survey /fig.1/. Its positive results represent a base for a construction of the new spa /Tylčer, 1977/.

Thin sandy laminas of the locality associate to zones where their density increases above the average value of 15 % that is verified for all the surveyed vertical interval of the Pelitic facies in the area /fig.3/. A lateral extent of sand zones is judged to be of an order of houndreds, maximally of the first thousand metres. The zones are mutually isolated and none of them has any priorities from a hydrogeological point of view. The average basic parameters of aquifer sands : effective porosity 27 %, d_{90} 0,20 mm, d_{60} 0,08 mm, d_{60}/d_{10} ratio 22,6, coefficient of permeability 5 EXP -6 m/s /extreme values 5 EXP -5 and 2 EXP -8/, coefficient of elastic storativity of order EXP -5. In the adjacent area with overlying Carpathian nappes hydraulic parameters rapidly decrease.

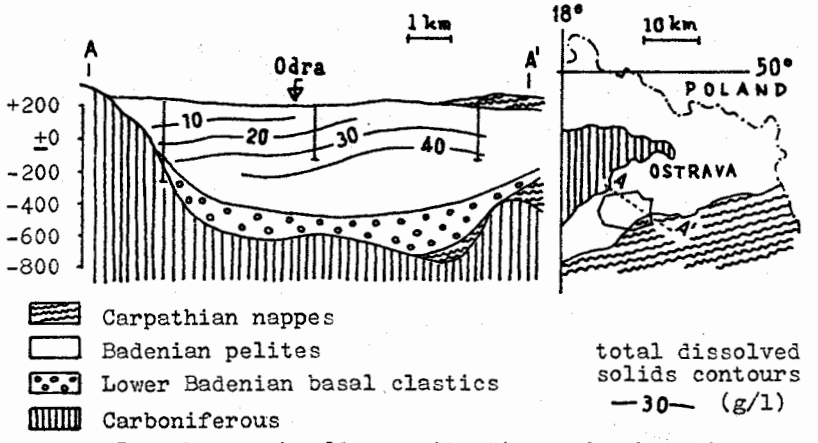

Fig.1 Polanka on the Odra - situation and schematic cross section with TDS concentration profile through the Lower Badenian pelitic facies. The protective zone II of the structure is sketched in the map.

The sands contain confined water of the Na - Cl type with high content of dissolved gas /methane/. A distinct vertical and lateral zonality is developed within the structure. It is manifested by variations of the TDS content within the interval 15 - 50 g/l /fig.4, 5/. The type of water is staying basically unchanged and testifies to an isolation of aquifers /fig.2/.

Water pressure show a similar zonality. The piezometer head differencies /fig.4, 6/ are not caused by water flow but they reflect a distribution of stress in the rock massif of the Pelitic facies owing to non-final stage of its compaction. To all appearance that phenomenon is not general for all the area of Tertiary cover in the region /Hufová, 1971, Rozkowski, 1971, Tylčer, 1977/.

For a completeness : water of the underlying Lower Badenian basal clastics are of a guite different chemistry /Na-HCO_3 with CO_2/ and its potentiometric surface is highly influenced by a regional drainage to mines.

All gathered information support a conception the Pelitic facies must be regarded as a consistent hydrogeological system regardless the development of separate water bearing zones that are isolated both internally and externally due to the composition fabric of the Pelitic facies. Synsedimentar water had been pressed out to sands in the course of a filtrate compaction of the structure /Jacquin, 1965, Balukonis, Chodkov, 1973/. The unfinished compaction is an important factor of a practical significance.

Three strata energy sources can participate in a flow to wells :

- elastic energy of the water - rock system
- expansion of gas released from water with dropping of pressure below a saturation value

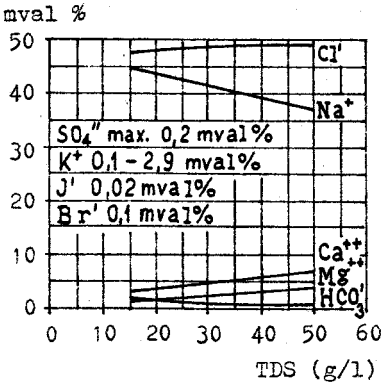

Fig.2 Relationship between chemical composition and TDS content

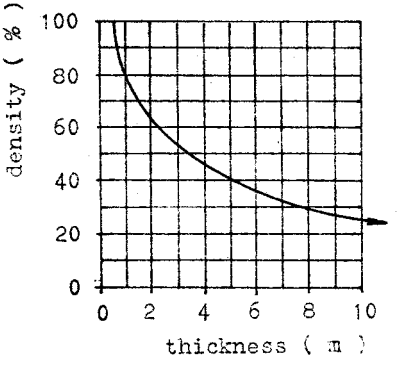

Fig.3 Statistical relation between thickness of zones with increased sandy lamination and its relative density

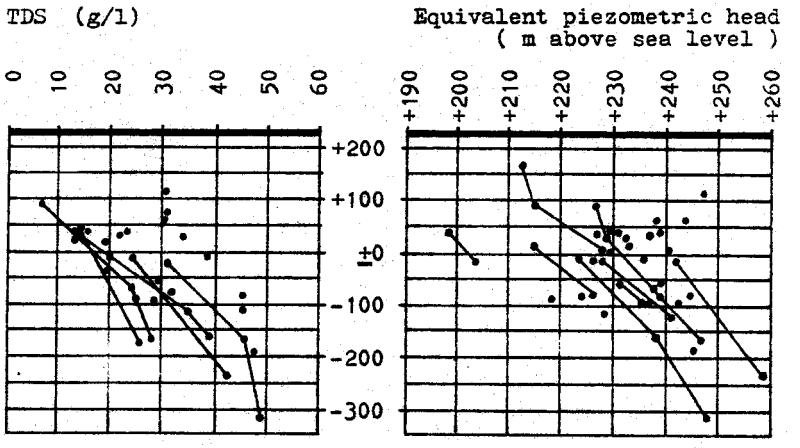

Fig.4 Depth dependence of TDS concentrations and pressures in aquifers of the Lower Badenian pelitic facies.
Lines tie data from the same well.
Average increase gradients in the surveyed depth interval :
TDS : 7,5 - 10 g/l / 100 m of depth
Equivalent piezometric head : 10 m / 100 m of depth

- non elastic gravitional compaction of aquifers caused by an overburden weight.

The last mentioned process may be the most important for "squeezing" water to wells : aquifers with large deformation capabilities cannot bear an increasing effective pressure evolved by drop of a pore pressure when water is withdrawn. A structural irreversible deformation of a skelet results in a subsequent pore pressure recovery. The value of a total pressure remains constant. These conclusions ensue as from pumping and recovery tests as from laboratory measurements.

An exploitation of mineral water for the new spa will be executed by submersible pumps from wells. An opening scheme and operational regime will have to be rather complicated. Capacities of single wells will not exceed tenths liter per second. A certain number of wells with various depths will be concentrated to the so called production centre to secure demanded water quantity. A new centre will have to be drilled after water reserves of the old one are exhausted.

There is a dense concentration of various economic activities in the area of the structure Polanka on the Odra. Legal restrictions had to be defined to protect it.

Thanks to proved perfect isolation properties of the Pelitic facies clays no dangers arise from surface and subsurface activities not exceeding the depth of 50 m. The topmost aquifers are not interesting for their low TDS content. It has been only necessary to ensure enough free area for drilling production wells within the protective zone II. It covers with sufficient reserve all the structure. The protective zo-

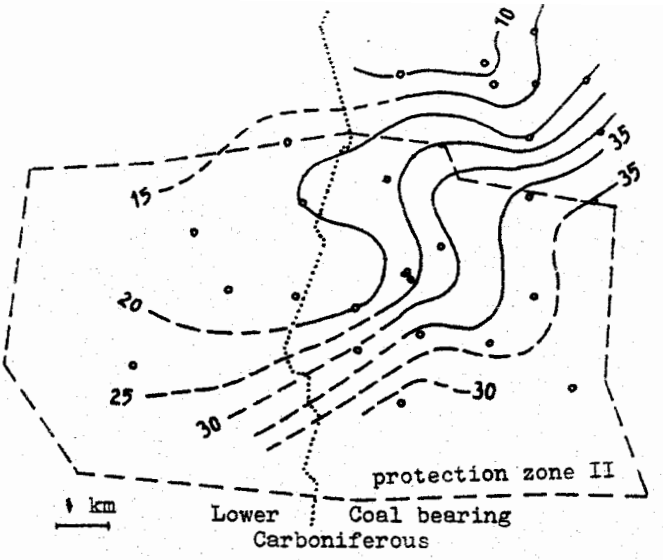

Fig.5 Total dissolved solids contours (g/l) of water of the Lower Badenian pelitic facies in the horizontal plane ± 0 m (above sea level).

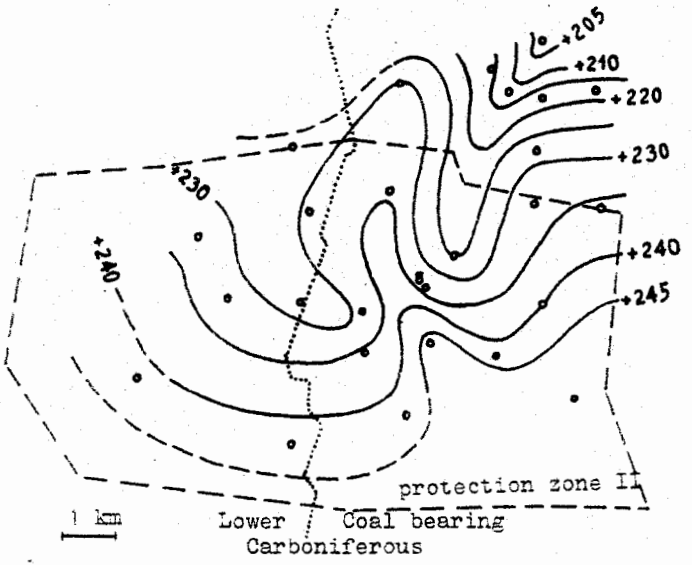

Fig.6 Equivalent piezometric head contours (m above sea level) of water within the Lower Badenian pelitic facies in the horizontal plane ± 0 m (a.s.l.).

nes I /50 m diameter circles/ ensure a protection of single wells and surface installations.

Preventive measures are prescribed for activities in depths exceeding 50 m /wells, shafts/ to protect aquifers from contamination, drainage, mutual connection and lossess of strata energy.

The most demanding task was an evaluation of possible risks ensued from a mining activity under the Pelitic facies in the Carboniferous itself. The productive Carboniferous lies under the eastern half of the structure. It is obvious groundlessly strict restrictions could result in blocking of large quantities of coal reserves.

Due to restricted lateral extent and mutual isolation of aquifers effects of a prospective mine drainage woul remain limited to areas of their direct contact with the Carboniferous. The protective zone II has been demarcated in such a way with regards to the Carboniferous relief that the drainage need not be taken into consideration at all. As for a development of water conductive discontinuities within the Pelitic facies an experience shows such impacts of undermining are limited to the nearest overburden only.

An another effect of mining activity represents the most serious risk for the mineral water structure : As discussed above the compaction of aquifer sands provoked by a water extraction is judged to be an important element of strata energy governing a flow to wells. An undermining could induce l o o s e n i n g of aquifer sands resulting in a drop of pressures. Beside a direct loss of this sort of strata energy a release of dissolved gas woul follow. It could give rise to a two-phase system in aquifers with a further impact on a water extractibility.

It can be deduced from analyses of mechanics of the process /Smith, 1971/ that with ceasing of all dynamic effects of undermining a regeneration of pore pressures ought to follow. Thus negative impacts of undermining ought to be only temporary. The subsidence process itself is decisive, not its absolute results. As to the reach of undermining the limited areal extent of single aquifers is a merit again.

Dynamic effects of an undermining must be strictly precluded within the drainage area of an actual production centre to prevent temporary negative affection of an exploitation regime. It is also significant for the very reason of precluding physical damages of wells.

But even the full exclusion of mining from the reach of actual produtction centre will not mean definitive losses of the coal reserves. They can be released with shifting the production centre to a new place after water reserves of the old one are exhausted. The spa complex itself will be built in the area of non-productive Lower Carboniferous with primarily higher qualities of an life environment.

So the coexistence of the mineral water exploitation and the subjacent coal mining is acceptable in the area on the condition the time and space coordination of the both activities is ensured.

References :

Balukonis, G.J., Chodkov, A.E., 1973, Geologičeskie zakonomernosti dviženija podz. vod, neftěj i gazov, Izd. Leningradskogo universiteta.

Hufová, E., 1971, Hydrogeologický průzkum vymýtin OKR, Geofond Praha.

Jacquin, C., 1965, Interactions entre l´argaile et les fluides écoulements á travers les argiles compactes, Etude bibliographique, "Rev. Inst. Franc. petrol", vol. 20, No 10.

Rozkowski, A., 1971, Badania srodoviska hydrochemicznego utworow Dolnotortonskich u PZ czesci zaglebia Gornoslaskiego, Bull. Inst. geol., nr. 249, Warszawa.

Tylčer, J., 1977, Polanka n. Odrou, záv. zpráva II. etapy, Geofond Praha.

Tylčer, J., 1985, Hydrogeol. posouzení náhrady lázní Darkov, MS, Geofond Praha.

Smith, I.E., 1971, The dynamics of shale compaction and evolution of pore-fluid pressures. "J. Inst. Assoc. Math. geol.", vol. 3, No 3.