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HYDROGEOLOGICAL DIVISION OF THE CZECHOSLOVAK PART OF THE UPPER SILESIAN COAL BASIN

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ABSTRACT

Results of a recent survey activity have enabled the synthesis of hydrogeological knowledge and hydrogeological zoning of the Czechoslovak part of the Upper Silesian basin. It is to be a base for formulation of actual investigation tasks according to needs of a coal mining.

Apart from the massif of the Epivariscian platform the part of which is the Carboniferous itself five hydrogeological systems are distinguished in the region. The most significant one is a huge aquifer of the Lower Badenian basal clastics regionally developed in the classical part of the Ostrava-Karviná mining district.

Hydrogeological conditions of a mining are determined by the character of systems overlying the coal bearing Carboniferous. According to properties and an areal distribution of individual overlying systems the region can be zoned into the Northern and Southern parts.

A brief description of hydrogeological systems and an evaluation of their effects is given in the paper.

INTRODUCTION

The Epivariscian and the discordantly superposed Neoidic structural etages are two principal units taking part in the structure of the Czechoslovak part of the Upper Silesian coal basin.

Six hydrogeological systems are distinguished in the region :

- Hydrogeological massif of the Epivariscian platform the highest member of which is the productive Carboniferous. The Lower Carboniferous, the Devonian and crystalline basement are the further members.

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- Autuchtonous Karpatian aquifers.
- Aquifers of Outer Carpathian nappes.
- Basin structure of the Lower Badenian basal clastics /called "detrit" in a mining practise/.
- Aquifers of the Lower Badenian pelitic facies.
- Quarternary aquifers.

Results of a hydrogeological survey activity in the region aimed at needs of a mining have been presented in detail by Hufová /1971, 1985/. A long list of other authors that have contributed to today´s knowledge can be enumerated : Vladimír Homola, R. Jirkovský, A. Jurková, G. Kačura, R.Květ, J. Majzlík, R. Michálek, J. Pišta etc.

A BRIEF DESCRIPTION OF INDIVIDUAL HYDROGEOLOGICAL SYSTEMS

Epivariscian platform

A fissure permeability is decisive for the massif. Groundwater occurrence is bound on joints, faults, fractured zones and on a weathered relief of the buried platform.

Only rare hydrogeological data /mainly from an oil and gas prospection/ are at disposal as regards the older stratigraphical members of the massif. No special attention must be paid them when hydrogeological problems of a coal mining are solved.

As to the p r o d u c t i v e C a r b o n i f e r o u s its hydrogeology is determined by hydrogeological character of units overlying it. Practically all groundwater inflows to mines originate from aquifers which are in a direct contact with the Carboniferous relief.

Even an arenaceous and rudaceous Carboniferous rocks lack a porous permeability. Certain weathered psammites of the Karviná formation are the only exemption. An existence of coarser rocks is important for their rigidity that enable a groundwater communication through the massif discontinuities. Argillaceous rocks, coal beds and clay filling of faults reduce it irregularly. Results of one tracer test, by which the average flow velocity 27 m per day on 2,1 km distance was stated /Pišta, 1961/, have illustrated a communication possibilities of a Carboniferous tectonic even of a local order.

A chemical composition of the Carboniferous water corresponds to an overlying aquifer with which a hydraulic contact exists. Rare exemption with increased TDS contents and temperatures found in mines have been attributed to ascendent inflows from series beneath the Carboniferous /Majzlík, 1969/.

A mining activity gives rise to new water conductive paths in the massif. Original groundwater regime as of the

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Carboniferous as of overlying aquifers is affected in a large scale by a mining in the area of the Ostrava-Karviná Carboniferous ridge.

Autochtonous Karpatian

Impermeable rocks prevail in the unit lying on the platform relief as the oldest component of the Neoidic structural etage in the area covered by the overthrust Outer Carpathian nappes.

Interposed aquifers of irregular - mostly lenticular - areal extent reach thicknesses from few cm to few metres. Only two aquifers can be correlated through comparatively large area in Frenštát and Kopřivnice survey fields. In the Frenštát area close aquifers near the base of the Karpatian associate to a united hydraulic system. Typical permeability coefficient values of Karpatian aquifers reach orders from EXP-8 to EXP-6 m/s.

Aquifers are closed and without a connection with zone of a shallow hydrogeological cycle. They carry water of a quite stable chemistry of the natrium-chloride type with TDS contents 20 - 30 g/l and with considerable portions of iodides and bromides. A high content of dissolved gas /methane/ is typical too and dry gas can be found in some permeable stratas.

Piezometric heads of water varying about + 170 m /above sea level/ correspond to strata pressures from 5 to 10 MPa according to depths of aquifers.

A communication with Karpatian aquifers lying on the Carboniferous relief will have to be supposed and respected when a coal mining in the area of virgin southern fields is developed.

Outer Carpathian nappes

A poor water conducting capability is characteristic for the nappes in general. In detail a permeability varies with a lithology of individual stratigraphical members. It is mostly the fissure permeability with typical values up to EXP-7 m/s.

Relative intensive descendent communication of phreatic water is limited to depths not exceeding one hundred metres from a surface.

Water chemistry of deeper aquifers witnesses for their isolation. The natrium-chloride water type with TDS content of tenths g/l is standard. Water contain gas /methane/ and an existence of gasseous horizons /often with increased pressure/ is common.

Some tectonic zones may mediate a communication of a fairly large vertical extent within the nappes.

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Lower Badenian basal clastics

This hydrogeological system is the most significant in the North of the basin.

The clastics continuously fill the base of depressions that fringe the Ostrava-Karviná Carboniferous ridge as from the North /the Dětmarovice depression/ as from the South /the Bludovice depression/. The maximum thickness of the clastics reaches cca 280 m. Their surface varies about - 500 m /below sea level/. Clays of the Lower Badenian pelitic facies are an impermeable roof for the basal clastics confined aquifer. With an exemption of the southern periphery where nappes and autochtonous Karpatian reach from SE the basal clastics lie directly on the Carboniferous. It represents generally an impermeable base for them. But fractured zones and irregularly preserved weathered zone of the Carboniferous are a part of the basal clastics aquifer system.

Hydraulic parameters of the clastics vary in a wide range and a contemporary density of survey data does not make possible to couch conclusions regerding to their areal distribution. Veryfied values of a porosity are 8 - 20 %, an elastic storativity from EXP-2 to EXP-6, a coefficient of permeability from EXP -5 to EXP-8 m/s. The highest values come from the west of the Bludovice depression.

Basal clastics groundwater is in majority of the natrium-chloride type. It can be expressed by Alekin`s symbol $Cl\,Na_{III\,b}$. A dissolved solids contents increase with depth and to centres of depressions. The highest known TDS content is 65,4 g/l. Water is highly saturated by gas in which methane prevails /over 90 %/. Even a dry gas deposit have been discovered and exploited from a structurally controlled trap in the SE of the Bludovice depression.

To the western part of the Bludovice depression and further to an adjacent depression of Moravian Gate the water chemistry changes to the natrium-bicarbonate type with a carbon-dioxide saturation /Alekin`s symbol C^{Na}_{I}, exceptionally C^{Mg}_{I} /. TDS contents reach 5 - 10 g/l.

The basal clastics aquifer is isolated from a shallow hydrogeological cycle. A limited contact may exist only through exposed Lower Carboniferous rocks in the western peripheries of the Bludovice and Moravian Gate depressions.

An original potenciometric surface of the basal clastics groundwater is supposed to have been + 175 m /above sea level/ /Homola, 1957/. That height was measured in 1902 when a catastrophe on the Bedřich shaft revealed and existence of the basal clastics for the first time. The same height has been confirmed by the newest survey results from the westernmost /isolated?/ part of the Dětmarovice depression.

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A long-time spontaneous drainage to mines of the Ostrava-Karviná Carboniferous ridge has highly influenced the potentiometric level of the basal clastics aquifer in all the area. The water level fall reaches values 4 - 10 m per year. The deepest level -399 m below sea is documented by an observation well near the Carboniferous ridge in the eastern part the Dětmarovice depression in 1985.

Elastic groundwater reserves have been draining till the present time. A rate of a piezometric level descent will slow down with a continuing drainage when an actual dewatering of the aquifer begin in a larger scale. The main volume /95 %/ of the basal clastics lies below the level -400 m and 80 % below the level -500 m. The aquifer regime has been begining to be complicated also due to gas released from water with dropping of pressure.

Lower Badenian pelitic facies

An absolute prevealence of aquicludes is typical for this system. Its clays represent the hughest mass of the Neoidic structural etage to the northward from a territory of Carpathian nappes. They partly overthrust its SE periphery.

Interbedded water-bearing low-permeability thin stray sands and sandstones of the pelitic facies may associate to few metres thick zones where a sandy lamination prevails. The only zone is spread through a large part of the Lower Badien foredeep /so called the main sandstone horizon/.

All aquifers close water of the natrium-chloride type with significant concentrations of iodide and bromide ions. Alekin`s symbol is $Cl^{Na}_{III_b}$. A high content of dissolved methane is typical. TDS content shows as lateral as vertical zonality and varies in a range 10 - 50 g/l.

A spontaneous drainage of aquifers being in a contact with slopes of the Carboniferous relief occurs in a reach of exploited mine fields.

Quarternary

Significant quarternary aquifers are bound above all on alluvial and glacial deposits in the northern-lowland--territory of the basin.

Outcrops of the Carboniferous elevations beneath flood plains of the Odra, Ostravice and Lučina river are the only areas where the Carboniferous is in a contact with shallow groundwater cycle. It is a factor of a great practical significance for some mines in Ostrava.

CONCLUSIONS

Effect of hydrogeological conditions on a mining acti-

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vity in the Czechoslovak part of the upper Silesian basin is determined dominantely by a character of systems overlying the coal-bearing Carboniferous. According to properties and an areal distribution of individual overlying hydrogeological systems all the basin can be divided into the Northern and the Southern parts.

The hugh aquifer of the Lower Badenian basal clastics is the dominant factor for the N o r t h e r n p a r t . It is due to its position directly on the Carboniferous relief and due to its large capacity and a regional extent and due to high water pressures.

Local contact of the Carboniferous with Quarternary groundwater is another factor of practical significance that is typical only for the Northern Part.

All but one existing mines of the basin are located in its Northern part defined here. More than 20 millions cubic metres of water per year is pumped from all mines which corresponds to ratio 0,9 cubic metre of water /1 ton of coal. About 85 % of the total water volume is equally divided between inflows from the Lower Badenian basal clastics and from the Quarternary /Quarternary inflows are concentrated to few mine fields only/.

A lowerning of water pressures of the Lower Badenian basal clastics aquifer has been mainly due to its spontaneous drainage till now. A passive protective mine measures prevail and it leads to blocking of large reserves of coal. Next development of a coal exploitation within a reach of recent mines calls for new approaches that are conditioned by an enlargement of knowledge. A project of a large hydrogeological survey has been prepared recently. A problem of a liquidation of large quantities of saline water is a difficult parallel task to be solved.

The S o u t h e r n p a r t of the basin is identical with new virigin area where a development of a mining activity is a matter of a near future. The Carboniferous is there overlied mostly by the autochtonous Karpatian which is covered by mass of the Outer Carpathian nappes. Individual aquifers and gasseous horizons of those formations have much lesser extents and capacities in comparision with the Lower Badenian basal clastics on the North. But their structure complexity and development irregularities ask preliminary for the passive protection measures of the comparable extent.

Groundwater of some tertiary aquifers on the North are interesting for significant concentrations of iodides and bromides. Water is exploited for medical purposes and a protection against effects of a coal mining is another task for practical hydrogeology in the basin.

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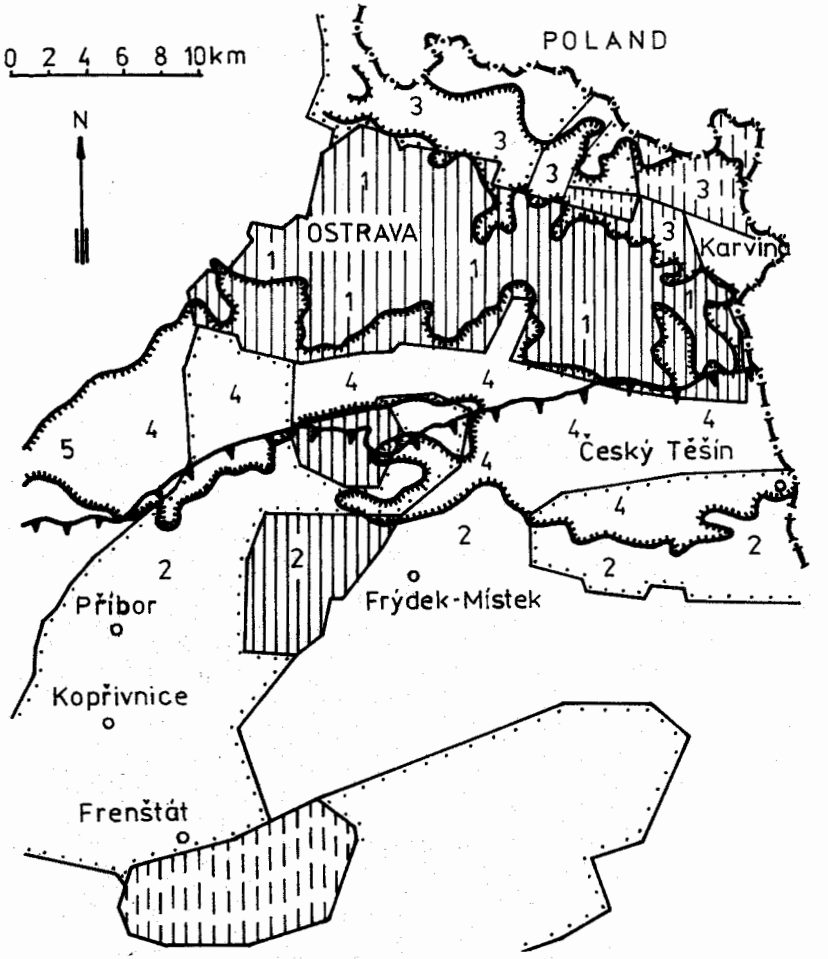
Fig.1 The Czechoslovak part of the Upper Silesian coal basin



Structure elements of the Carboniferous relief:

1 Ostrava-Karviná ridge
2 Příbor-Těšín ridge
3 Dětmarovice depression
4 Bludovice depression
5 Moravian Gate depression

exploited coal mine fields
fields to be exloited in near perspective
survey fields
Limit of the Lower Badenian basal clastics
Northern margin of the Outer Carpathian nappes

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