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THE INFLUENCE OF WATERS FROM HARD-COAL MINES ON THE HYDROCHEMICAL RELATIONS OF UPPER SILESIAN COAL BASIN (USCB) RIVERS

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ABSTRACT: Surface waters of the Upper Silesian Coal Basin (USCB) are highly transformed in quality as a consequence of salty minewater discharge to the hydrographic net. These waters drain coal beds which are extracted to a depth of 1000 m. The amount of minewater, discharging directly or indirectly to the river net of the USCB reaches 8–9 m^3/s with a variability in particular years of 1–1.5 m^3/s, which depends on hydrological conditions of the levels extracted. In 1994, the salt load introduced together with these waters to the Vistula and the Oder reached 6793 tons per 24 hours of chloride ions and 1351 tons per 24 hours of sulphate ions. This accounted for over 50% of the chlorides and about 35% of the sulphates discharged to surface waters in the country. Furthermore, a part of the minewater also contains radioactive elements (radium^{226}). The chance to improve the quality of the Oder and Vistula waters in the nearest future is meagre.

KEY WORDS: minewaters, hydrochemistry, water quality, salinity of river waters, Upper Silesian Coal Basin.

INTRODUCTION

In urbanized and industrialized areas where intensive mining in the shape of the exploitation of underground and open-cast-resources takes place there is indirect and direct discharge of mmewaters to the surface water net.

These waters originate from: 1) the draining of underground mining levels which under normal conditions play little or no part, in the local water circuit, 2) the draining of excavations for open-cast exploitation mineral resources.

Draining work is carried according to a program for the development of exploitation works as well as considering safety after the finishing of mining. Because mines exploit deposits in different geological structures characterized by variability in hydrochemical conditions, the minewaters which are pumped out differ in chemical composition and are very often considerably mineralized

(Różkowski 1995; Sawicki Gutry-Korycka 1993; Wilk, Adamczyk, Nałęcki 1990). Therefore minewater discharges disturb the natural water regime of streams and cause an increase in river pollution. A. Różkowski (1995) states that the general mineralization of underground waters in the area of the Upper Silesian Coal Basin (USCB) is very variable and fluctuates within the range 0.5–372 g/dm^3 and there is an increase in mineralization with the depth as well as simultaneous variability of its hydrochemical type from multiionic to bi- or triionic-brines.

Thus mines which exploit coal deposits up to the depth of 600–700 m (maximum 1000 m) drain water-bearing horizons characterized by differing water mineralization. In the 80s it was estimated that indirect or direct minewaters draining from coal mines in the Upper Silesia area amounted to 8–9 m^3/s with variability in particular years within the range 1–1.5 m^3/s, depending on the hydrochemical situation of the exploited horizons. Waters of total mineralization up to 1.5 g/dm^3 were introduced into the surface hydrographical system in the amount of 3.5–4.0 m^3/s, but above 1.5 g/dm^3 – 5.0 m^3/s. Strongly mineralized brines of salt concentrations above 70 g/dm^3 were drained only at 0.08–0.1 m^3/s. Recently there has been a "sweetening" of underground waters which are within the range of mine activity, especially in areas where coal exploitation has been carried on for more than 100 years (Gajowiec, Różkowski 1988).

This paper is an attempt to estimate the influence of minewater discharge from the hard coal mines of USCB on the shaping of the hydrochemical conditions of river waters, considering mostly salinity and the salt load removed from this area by the Vistula and Oder rivers.

THE AMOUNT OF MINEWATERS PUMPED OUT

In the period 1980–1987, the amount of minewater pumped out in Poland was kept at a near constant level, with a decreasing trend after 1987 (Table 1). In 1980 the amount of water pumped out was 1273 M m^3, and in 1993 1042 M m^3, which converted to a flow of 40.37 m^3/s in 1980 and 33.06 m^3/s in 1993 (*Ochrona środowiska...* 1981, 1991, 1994).

The majority of minewater is pumped out in the province of Katowice which is the most industrialized in the country. Their share in the total amount of minewater pumped out in the country is about 50% but there has been a slightly decreasing trend in the last few years (from 54.03% in 1980 to 48.4% in 1993). The amount of minewater pumped out in the province of Katowice and the two following ones (Piotrków and Konin) is above 80% of the total pumped out in Poland, and all provinces mentioned in the Table 1 account for 90%. The remaining provinces, where drainage work connected with resource exploitation took place, discharge only from 9.5% (1980) to 5.2% (1993).

TABLE 1. The amount of minewater pumped out in Poland in the years 1980–1993

Provinces (country)	The amount of minewater pumped out (in dam^3) in:				
	1980	1985	1987	1990	1993
POLAND	1,273,102	1,273,031	1,264,693	1,207,086	1,042,507
Katowice	688,026	644,001	659,108	596,401	504,532
Piotrków Tryb.	228,654	261,377	201,002	219,289	208,340
Konin	153,145	160,363	169,509	187,664	160,312
Legnica	31,852	51,836	56,747	51,626	48,877
Tarnobrzeg	22,392	45,610	48,408	45,394	17,728
Opole	1800	36,870	44,709	35,871	33,973
Wałbrzych	26,259	20,445	20,904	16,521	14,707
Others	120,974	52,529	64,304	54,320	54,041

Source: *Ochrona Środowiska...* 1981, 1991, 1994.

Fluctuations in amounts of drained minewater were connected with both hydrogeological conditions and intensity of exploitation. A significant part of the minewater is used for municipal and industrial purposes. The remainder, considering significant pollution, is discharged directly to the surface water network or temporarily retained in special reservoirs which are called dosing ones and discharge to rivers in amounts proportional to actual capacity. In the area of USCB, the thermal-chemical method is applied to utilize minewaters which are strongly saline. This entails evaporating water in a multistage system of evaporators, and crystallization of sodium chloride and calcium sulphate (Węgrzynowska 1993). The "Dębieńsko" hard coal mine in Czerwionka has Poland's only desalinating plant which processes about 2000 m^3 brine per day and simultaneously produces 129 tons per day of sodium chloride and 1000 m^3 per day of demineralized water. This plant utilizes only 2% of the salt load discharged to rivers by mining (*Raport...* 1995).

THE ORIGIN OF MINEWATERS IN THE AREA OF USCB

The minewaters originate from the draining of three geological formations (Rogoż, Staszewski, Wilk 1987; Różkowski, Przewłocki 1987): 1) Quaternary formations, from the opencast exploitation of stowing sands, 2) Triassic formations, from the underground exploitation of zinc and lead ores, 3) Carboniferous formations, from the underground exploitation of hard coal carried on at different depths — maximally at 1000 m.

The amounts of waters pumped out in the Upper Silesia area in the years 1970–1987 was within the range 20–21 m^3/s (Czaja, Jankowski 1992; Jankowski 1987) and after 1994 it decreased to about 16 m^3/s (Table 2).

TABLE 2. The amount of minewater pumped out from the mines of the Upper Silesian Coal Basin (USCB) in the years 1967–1994

Mines	Amount of water pumped out in m^3/s						
	1967–1976	1980	1985	1987	1990	1992	1994
Stowing sand	4.08	4.08	3.70	3.16	3.05	2.61	2.96
Zinc and lead ores	6.35	6.38	5.85	5.36	3.23	3.14	3.08
Hard coal	10.45	10.41	11.00	11.90	10.15	10.51	9.94
All	20.88	20.85	20.65	20.42	16.43	16.21	15.98

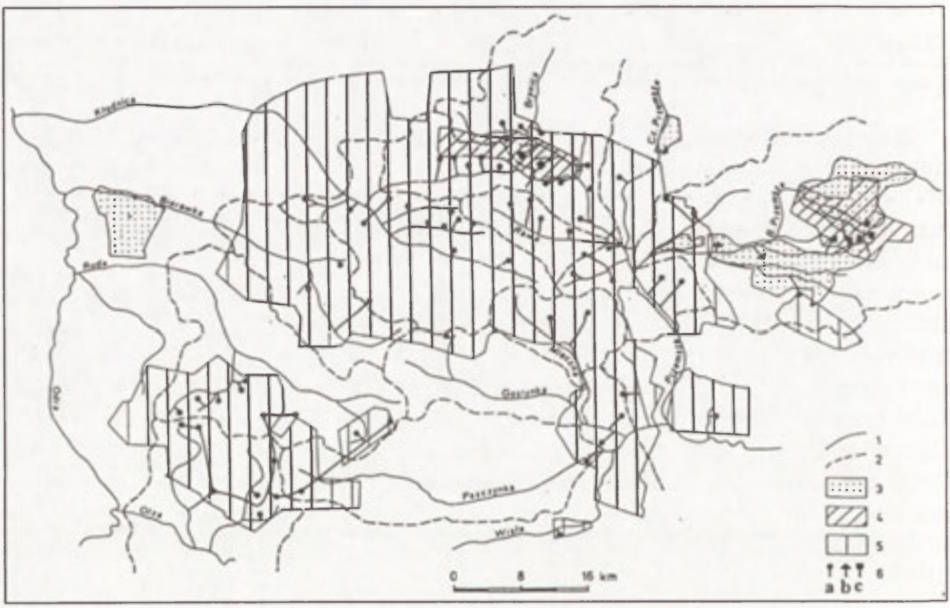

Fig. 1. Places of minewater discharges to the surface water network of Katowice province (after Czaja & Jankowski 1992)
1 — rivers, 2 — watersheds, 3 — areas of stowing sand exploitation, 4 — areas of zinc and lead ore exploitation, 5 — areas of hard coal exploitation, 6 — directions of drainage and places of the minewater discharge: a — from hard coal mines, b — from stowing sand mines, c — from zinc and lead mines

Half of the minewater pumped out, above all waters from mines of stowing sand and zinc and lead ores, is used as drinking or industrial water and after use is discharged to the sewerage system in the shape of wastewater. The remaining minewaters — mostly strongly-mineralized ones — are discharged directly to the surface hydrographic net (Czaja, Jankowski 1992), *vide* Fig. 1.

MINERALIZATION OF MINEWATERS

The mineralization of natural minewaters ranges from 0.2 to 372.6 g/m^3 (Różkowski 1995; Różkowski, Rudzińska, 1983). M. Rogoż, M. Staszewski and Z. Wilk (1987) estimate that at the beginning of the 80s the amount of minewater from hard coal mine drainage amounted on average to 960,000 m^3 per day which made 11.1 m^3/s in four minewater quality classes which differed in the content of Cl^- and SO_4^{2-} ions (Table 3).

TABLE 3. Amount of water pumped out from mines of hard coal in the area of the Upper Silesian Coal Basin, in particular classes of water quality (after Rogoż, Staszewski and Wilk 1987)

Class	Content of Cl^- and SO_4^{2-} ions kg/m^3	Amount of waters pumped out thousand m^3 per day	Percentage share
I	< 0.6	427	45
II	0.6–1.8	232	24
III	1.8–42.0	278	29
IV	> 42.0	23	2
Total		960	100

Waters of low mineralization which belong to the first class originate from upper exploitation horizons (depths to 400 m) and are drinkable but those from the second class can be used only for industrial purposes. Waters of the third class (weakly saline) which originate from excavations located lower down are only useful to a limited degree so are discharged to the surface hydrographic net. Part of them is utilized at the new station for desalination, located at the existing plant desalinating the "Dębieńsko" hard coal mine. A connected method of desalination is used here which consists in the increase in concentration of weakly saline waters by reverse osmosis. This way about 13,300 m^3 water per day can be utilized. Water of the fourth class (brine), where concentrations of chlorine-sulphate ions exceed 42 g/dm^3, cannot be used for economic purposes and is also discharged to the hydrographical net. This brine can only undergo utilization at 2000 m^3 per day by way of the thermal-chemical method at the "Dębieńsko" desalination plant in Czerwionka.

On the base of a prognosis for water inflow to the coal mines of the USCB up to 2005, worked out by Main Mining Institute (GIG) in Katowice, I. Węgrzynowska (1993) states that the amount of waters of III and IV classes will increase by 57%, while in class I it decreases by 11% and in II by 23%; the overall salt load discharged to rivers will increase by 28%.

So large an amount of minewater discharged to the surface and especially waters of increased mineralization, is not without influence on river water quality. The load of salt which is discharged from the mines to rivers of the

Vistula and the Oder basins was estimated in the mid-80s by M. Rogoż, A. Różkowski and Z. Wilk (1987) at 6900 tons per day, but in 1993 W. Szczepański and others (1995) evaluate it at 4834 tons per day including 4453 tons of chloride ions (Cl^-) per day and 381 tons of sulphate ions (SO_4^{2-}) per day. In 1994 the salt load discharged by the Vistula and the Oder rivers from the mines of USCB, calculated by the author on the base of data from the Centre of Research and Monitoring on Environment (OBiKS) (*Monitoring*... 1995), amounted to 6793 tons of chloride ions per day (for the Vistula — 6442.2 and for the Oder 1351.0 tons per day) and 1062.5 tons of sulphate ions per day (Table 7).

An estimation of Visula river pollution in the region of the Przemsza confluence, caused by the discharge of minewaters, was made by A. Różkowski and others (1986) and by B. Gajowiec and J. Różkowski (1988) on the basis of hydrochemical analyses of river waters realized in 1985 (Table 4). Hydrochemical research was performed then in the winter, spring, summer and autumn seasons in some sections (Fig. 2A).

Differences in chemical composition and overall mineralization between sections investigated on the Vistula are presented in hydrochemical profiles (Fig. 2B). Mean mineralization of the Vistula waters in 1985, specified for mean low and mean flows, increased from 0.2 g/dm^3 in the section of Goczałkowice to the maximum value of 3.1 g/dm^3 in Czernuchowice, where minewaters from three coal mines are discharged to the Przemsza above its confluence. The salt load of the Little Vistula waters from the USCB area minewaters caused multiple and overstandard increase in the pollution indicators as follows: dissolved compounds 1400–2550%, chlorides 1500–2750% and sulphates 1550–3900%. It conforms to the following absolute values: dissolved compounds 7400–9300 tons per day, chlorides 3600–4650 tons per day and sulphates 640–800 tons per day (Gajowiec, Różkowski 1988). The mineralization in the Dwory section amounts to 2.7 g/dm^3 in consequence of the inflow of the more-badly mineralized waters of the Przemsza and the Soła rivers (Różkowski et al. 1986).

TABLE 4. Concentration of ions and salt loads in waters of the Vistula and its tributaries in 1985 (after A. Rożkowski et al. 1986)

Stream	Profile	Concentration in g/m^3			Load in tons per day $Cl^- + SO_4^{2-}$
		Cl^-	SO_4^{2-}	mineralization	
Vistula	Jawiszowice (1)*	386.0	55.75	826.7	242.0
Vistula	Nowy Bieruń (2)	1740.0	146.30	3169.3	2098.0
Vistula	Dwory (3)	1371.0	234.00	2786.5	5034.0
Gostynia	Bojszowy (4)	6037.5	406.50	10 498.5	1779.1
Potok Goławiecki	Czarnuchowice (5)	16 912.2	1009.20	29 229.0	919.6
Przemsza	Jeleń (6)	456.5	274.20	1492.0	1011.6

* numbers of profiles are as in Figure 2.

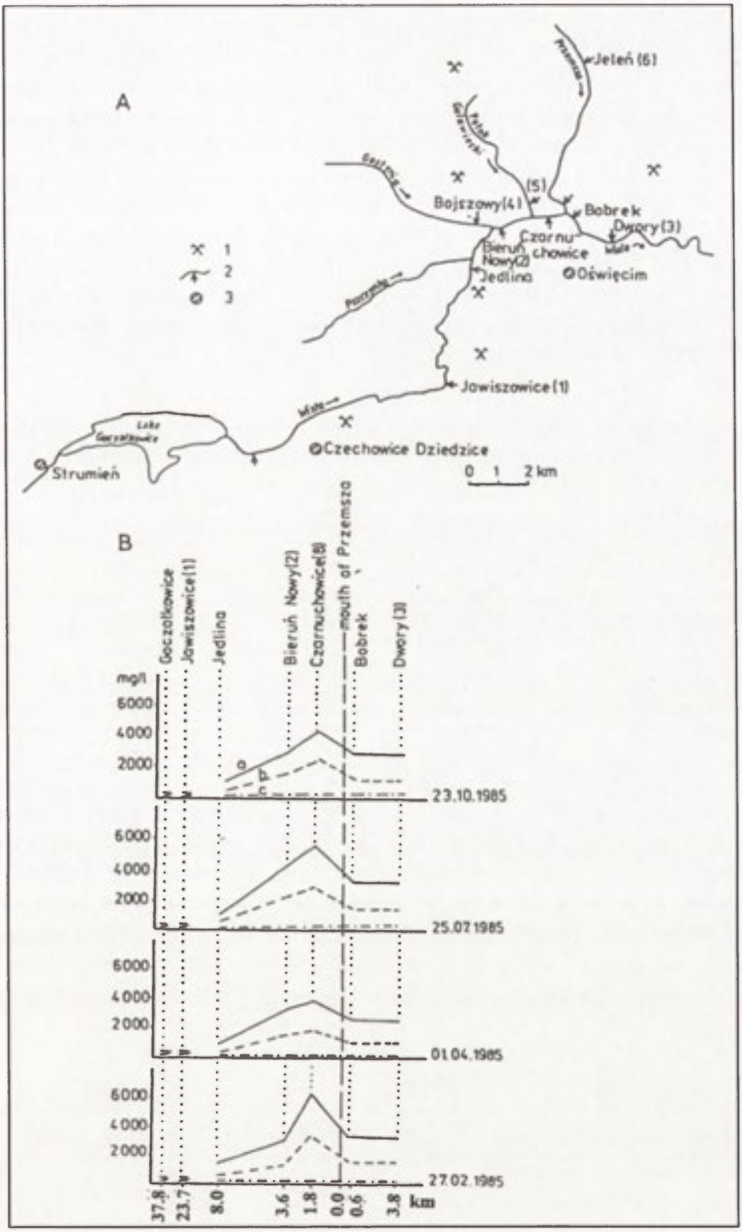

Fig. 2. Sketch of the hydrological net in the region of the Przemsza confluence with the Vistula (after Rożkowski et al. 1986):
A — location of hydrochemical profiles: 1 — hard coal mines which drain saline minewater, 2 — paces of water sampling for hydrochemical analyses (numbers in brackets comply with he profiles in Table 4), 3 — localities, B — hydrochemical profiles of the Vistula:
a — overall mineralization, b — content of Cl^- ion, c — content of SO_4^{2-}

On the basis of archival materials from the 1980 analysis, verified by measurements in 1985, A. Różkowski and others (1986) state that the amount of minewater discharged to the Vistula catchment closed by the profiles Jawiszowice and Dwory (Fig. 2) amounted to 8.49 m^3/s. These waters contained a total load of both chlorides and sulphates of 4027 tons per day. In the profile of Dwory the salt load discharged by minewaters made 78% of the river pollution total load. In 1993 — 388.1 thousand m^3 per day of minewaters (4.49 m^3/s) containing 3382.4 tons per day of chlorides and 270.7 tons per day sulphates were discharged to the Vistula. 79% of this load was discharged to the Vistula by its tributaries: the Gostynia (57%) and the Potok Golawiecki (22.6%). The amount of minewater, as well as the salt load, which were discharged to the Vistula in 1993 are presented in Table 5.

TABLE 5. Amount of minewater and salt load discharged to the Vistula and its tributaries in 1993 from the area of the USCB (after Szczepański et al. 1995)

River	Amount of minewater m^3 per day	Load in tons per day		
		Cl^-	SO_4^{2-}	$Cl^- + SO_4^{2-}$
Gostynka	71,261	1931.18	91.55	2022.73
Potok Goławiecki	35,693	878.99	50.63	929.62
Przemsza	251,418	268.75	123.40	392.15
Little Vistula	14,006	271.88	1.42	273.30
Vistula (Gromiec profile)	15,842	31.61	3.75	35.36
Total	388,220	3382.41	270.75	3653.16

In 1993 — 126.7 m^3 per day of minewaters with a total load of 1181.7 tons per day were discharged to the Oder. The quantity of waters and salt load introduced into the Oder tributaries are presented in Table 6.

Excessive pollution of the Vistula and Oder waters caused by the discharge of minewaters from coal mines has been observed since the 70s (comparison of salt load in the water of the Vistula between the profiles Jawiszowice and Dwory in the years 1976 and 1985 is presented in Figure 3).

TABLE 6. Amount of minewater and salt load discharged in 1993 to rivers of the Oder catchment from the area of the USCB (after Szczepański et al. 1995)

River	Amount of minewater m^3 per day	Load in tons per day		
		Cl^-	SO_4^{2-}	$Cl^- + SO_4^{2-}$
Klodnica	74,735	315.37	83.92	399.29
Olza	28,886	555.51	7.94	563.45
Bierawka	13,868	164.34	8.47	172.81
Ruda–Nacyna	9228	35.74	10.37	46.11
Total	126,717	1070.96	110.70	1181.66

The course of reliable concentrations of chlorides and sulphates in three profiles on the Vistula is presented above. In Jawiszowice, with mean annual low flow (MLQ) in the period 1976–1985 a more than 3-fold increase in chlorides concentration took place (from 520 mg/ dm^3 to 1750 mg/dm^3) but the concentration of sulphates increased insignificantly. In the profile of Bieruń Nowy a sixfold increase in the concentration of the Cl^- ions (from 850 mg/dm^3 to 5000 mg/dm^3) took place and the concentration of sulphates increased by 170 mg/dm^3, which means that it almost doubled. In the third profile — Dwory, a small increase in concentration was noted (chlorides by 650 mg/dm^3 and sulphates by 70 mg/dm^3 — Fig. 3). The comparison of the salt load in the waters of the Vistula and the Oder and its tributaries in the years: 1980, 1985, 1989 and 1994 is presented in Table 7.

TABLE 7. Mean annual salt load in waters of the Vistula and the Oder and their tributaries

River — measuring section	Indicator of salinity	Mean annual salt load in tons per day in the years			
		1980	1985	1989	1994
The Vistula river and its tributaries					
Little Vistula — Jawiszowice	chlorides	183.2	186.6	189.2	217.4
	sulphates	31.1	23.3	19.0	16.8
Little Vistula — Bieruń Nowy	chlorides	336.1	1308.1	2218.7	2643.3
	sulphates	89.0	99.4	139.9	182.3
Gostynia — mouth to Vistula	chlorides	99.1	1076.1	2027.5	1715.5
	sulphates	45.4	73.7	124.1	114.6
Potok Golawiecki — mouth to Vistula	chlorides	953.5	876.4	1022.4	877.1
	sulphates	52.3	43.2	48.1	47.8
Przemsza — mouth to Vistula	chlorides	604.4	732.9	1012.9	730.6
	sulphates	459.0	595.2	465.2	418.6
Vistula — Bobrek	chlorides	2043.3	3250.5	5158.3	5442.2
	sulphates	659.8	544.7	621.5	659.5
The Oder river and its tributaries					
Oder — Chałupki	chlorides	205.2	213.2	269.5	217.1
	sulphates	155.2	266.1	337.7	207.7
Olza — mouth to Oder	chlorides	200.1	148.8	357.4	419.0
	sulphates	37.3	50.3	40.1	47.8
Ruda — Ruda Kozielska	chlorides	74.7	90.1	142.9	281.3
	sulphates	31.1	36.7	39.9	50.2
Bierawka — Tworóg Mały	chlorides	389.7	287.4	829.8	313.9
	sulphates	37.0	35.5	55.5	45.8
Kłodnica — Łany Małe	chlorides	45.6	112.9	164.1	119.9
	sulphates	50.8	47.1	51.4	51.5

From the data presented in Table 7 it results that in 1980 the largest salt load was discharged to the Vistula by: the Potok Golawiecki and the Przemsza and since 1985 by the Gostynia and the Potok Golawiecki.

In the Oder basin located within the range of influence of the USCB, i.e. its left-bank tributaries (the Olza, Ruda, Bierawka and Klodnica) the largest amount of salt is discharged by the Olza and therefore by the Bierawka, Ruda and Klodnica. In the case of the Klodnica the role of "specific" settling

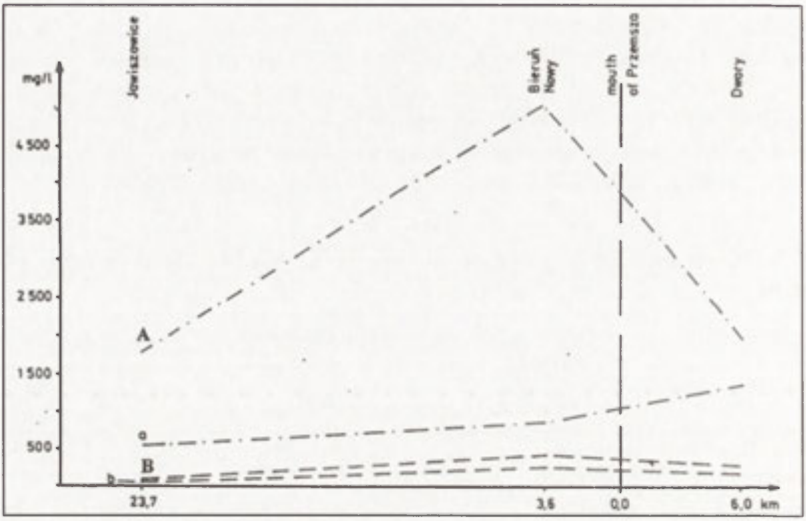

Fig. 3. Reliable concentrations of chlorides (a) and sulphates (b) for mean low flow (MLQ) of Vistula waters in 1976 (a and b) and 1985 (A and B)

tank in the years 1965–1994 was fullfilled by the Dzierżno Duże reservoir, which was finished in 1964. In the measuring section above the inflow of the Klodnica to the reservoir, the mean annual concentrations of chlorides in the years 1969–1975 amounted to from 835 to 1740 mg/dm^3. In 1977 the concentration of chlorides in this section amounted to 1635 mg/dm^3 and in 1994 — 1458 mg/dm^3. In the years 1969–1975 water in the reservoir contained significantly fewer chloride ions in relation to the water which flowed to it because the concentration of these ranged from 750 to 990 mg/dm^3. At the outflow from the Dzierżno Duże reservoir the concentration of chloride ions in 1977 amounted to 941 mg/dm^3 and in 1994 — 1368 mg/dm^3 (Rzętała, Wach 1995). It betokens the general increase in the salinity of the reservoir waters. The content of chlorides in water which outflowed from the reservoir conforms to its concentration in the water which inflowed. This situation now has a permanent (stabilized) character because the mean concentration of chloride ion in the period 04. 1994 — 04. 1995 in the reservoir water was still at the level of 1300 mg/dm^3 (Jankowski 1995).

It is very odd that the values given in Tables 5, 6 and 7, which confirm salt load discharged to the Vistula and the Oder and their tributaries are very different. It is rather unlikely that the load was bigger and bigger by so a big degree year by year. Values given by W. Szczepański and others (1995) base themselves on values for minewater discharges which were obtained from mines (Table 5 and 6). Calculations of the author from 1994 (Table 7) base themselves on the hydrochemical measurements of waters made by the Centre of Research and Monitoring on the Environment (OBiKS) in Katowice. Which values are more correct? In the opinion of the author the data from 1994 are right because they relate to really measured indicators of water pollution in the river. But these values of loads are polluted by the amount of chlorides and sulphates which are discharged in industrial wastewaters from the plants of other branches. OBiKS does not do precise research on wastewaters discharged in particular plants. It is sure that the chloride and sulphate ion load is not smaller than that estimated by W. Szczepański and others (1995). It is possible to think that these amounts are rather lowered. There is also the fact that in the overall load of pollutants discharged together with industrial and municipal wastewaters to the surface waters of Katowice province in 1993, chlorides and sulphates predominated. They accounted for over 50% of the total load of chlorides and about 35% of the sulphates which were discharged to surface waters in the country. Considering this, the share of minewaters from the USCB mines is unquestionable.

J. Krokowski and M. Karnas (1994) state that in the years 1989–1990 the mean percentage share of chlorides from minewater discharge in relation to the total chloride load in the Vistula above Cracow amounted to 83% and in the section of Warsaw — about 62% but in Kieżmark — the profile at the mouth of the Vistula to the Baltic Sea — about 38%. It is estimated that the excessive salinity of the Vistula waters is kept to the Wieprz confluence but in the case of the Oder remains along 277 km of its length, counting from the Olza confluence (Korol and others 1994).

In connection with the decrease in coal exploitation after 1985 the decrease in amount of minewater discharged to rivers as well as the decrease in the introduced chlorides and sulphates load followed. The decrease in introduced salt load is not as important as the decrease in the amount of minewater (Fig. 4).

Minewaters of some mines contain radioactive elements occuring in the formation, eg. radium (Ra^{226}) whose amount exceeds the values of the natural background. I. Węgrzynowska (1993) informs us that the concentration of radium Ra^{226} in minewaters of some mines amounts to: 17.3 kBq/m^3 — "Krupiński", 16.9 kBq/m^3— "1 Maja", 1.10 kBq/m^3—"Jankowice", 4–6 kBq/m^3 — "Piast"and "Czeczott" (but the maximum value is 20 kBq/m^3), 6.3 kBq/m^3 — "Silesia". The concentration for the natural background reaches 0.1 kBq/m^3; the standard for drinking water in Poland is determined as 0.11 kBq/m^3 (Węgrzynowska 1993). Research from the Main Mining Institute (GIG) in Katowice indicates that the minewaters do not put the inhabitants of the region at hazard radioactively but are not neutral for the natural environment. For this reason these mines undertake activities to remove radium from the minewaters. These exertions reduce the concentration of radium Ra^{226} to 0.4 kBq/m^3 in the case of the "Krupiński" mine.

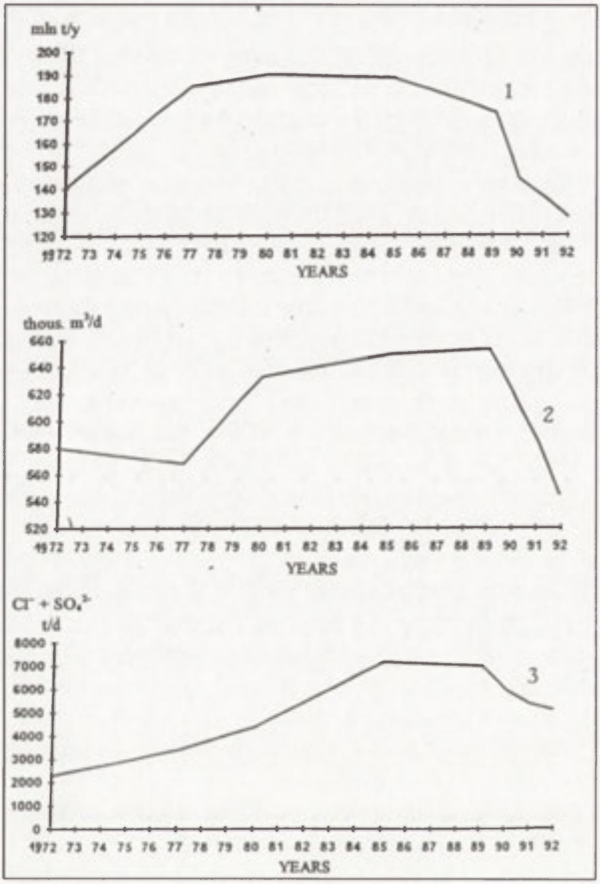

Fig. 4. Output of hard coal (1), amount of minewaters pumped out (2) and salt load (3) discharged to the rivers of Katowice province in 1972, 1977, 1980, 1985, 1989–1992 (after W. Szczepański — archival materials of IMGW — Katowice)

FINAL REMARKS

The above-presented data reveal that the influence of minewaters on the mineralization of river waters of the USCB area is very big and determines the salinity of rivers including the Vistula and the Oder. The excessive salinity of both rivers' waters is observed on rather long sections of their courses. As the years go by one should estimate that the excessive salinity of the Vistula and the Oder will move to the upper courses. The total salt load which is discharged to both rivers from the USCB reaches 5 thousand tones per day and thus accounts for over 50% of the overall chloride load and about 35% of the sulphates introduced into surface waters in the country.

The process of river water quality degradation in the area of Upper Silesia is also revealed as decrease in the dynamics of changes in the size of the transported salt load. This fact indicates that seasonal changes in water flow in the rivers have a smaller and smaller influence on the load size. It betokens important disturbance of their natural regimes. In some streams the amount of minewaters is greater than 50% of the total runoff. This has economic consequences as a result of the limitation of possibilities for use and the appearance of losses caused by accelerated disturbing of machineries which draw saline river waters for technological needs, e.g. in the ironworks of T. Sendzimir in Cracow. Prognoses made indicate that by about 2005, the amount of water pumped out by mines will have decreased by 14% but the concentrations of chlorides and sulphates ions will have increased by about 67% (Rogoż 1994) It will be caused by an increase in the mean depth of mine workings. Therefore the problem of salt water utilization will still be relevant and will be rather more sharpened. Although restructuring of the mine industry is being undertaken, the exploitation of coal (on a limited scale) is retained in the worked-out scenarios of spatial policy for the country's management (*Poland 2000 plus* 1995). Therefore a decided improvement of both Vistula and Oder water quality in near future is not a real possibility.

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