GROUNDWATER QUALITY IN THE UPPER VISTULA RIVER BASIN (SOUTHERN POLAND)

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Abstract

For the assessment of groundwater quality in th Upper Vistula River Basin (southern Poland, Fig.1) it was used data from Regional Groundwater Quality Monitoring (**RGQM**) of this basin, which was taken in 1993-1994 (1,2) and data from sampling of Major Groundwater Basin **MGWB 451** (which is a part of the Upper Vistula River Basin) in 2000-2001, within EU Fifth Framework Project „Baseline“ (4).

Figure1.

Localization of Regional Groundwater Quality Monitoring of the Upper Vistula River Basin and Major Groundwater Basin 451 in Poland

The hydrogeochemical data was verified (4,5,6,7) and with the use of probability curves (8) it was determined hydrogeochemical background for major and some trace elements (for the Upper Vistula River Basin and for the MGWB 451). The term hydrogeochemical background means concentration range of an investigated element or a group of elements occuring in groundwater (9). Hydrogeochemical background was compared to maksimum permissible levels (**MPL**) of analysed elements in drinking water according to Council Directive 98/83/EC.

In most cases hydrogeochemical background in the MGWB 451 is the same as in the Upper Vistula River Basis, only for Na and Cl we observe higher concentrations in the MGWB 451. This concentrations of Na and Cl result from anthropogenic and/or geogenic sources (4). The data show also that some values of Fe exceed the maximum permissible concentration in drinking water (10). They result from purely natural geochemical processes.

Introduction

The assessment of groundwater quality in the Upper Vistula River Basin was made on the base of results of the Regional Groundwater Quality Monitoring (RGQM) and results from sampling of Major Groundwater Basing 451 (MGWB 451) which is a part of the Upper Vistula River Basin (Fig.1). It was made on the base of hydrogeochemical background, calculated for some main and trace compounds.

The term hydrogeochemical background means concentration range of an investigated element or a group of elements occuring in groundwater (9,11). Most commonly hydrogeochemical background is calculated as a mean value (X) ± 2 standard deviation (s), X ± 3s, median (M) ± 2s, M ± 3s or X ± 1.96s (12). There are used also graphical methods: frequency histograms (9), probability curves (8) or box-plots with percentiles 16th and 84th (13,14).

In this article hydrogeochemical background of selected indicators (K, Na, Mg, Ca, Cl, SO_4, Zn and Fe) in the Upper Vistula River Basin was determined with the use of probability curves (8). According this method, hydrogeochemical background is defined as a median value M ± 1s.

Groundwater Quality in the RGQM

RGQM was taken in 1993-1994 and covers the Upper Vistula River Basin from the sources to the estuary of the Sanna River (about 50 000 sq. km).This area was identified at the begining of 1990s as the pilot area for the implementation of the integrated catchment water management scheme in Poland. The Regional Groundwater Quality Monitoring network consists of 172 regional monitoring sites (earlier suitably classified and adopted).

Data (values of groundwater physico-chemical indicators) was verified on the base of results of quality assurance/quality control program (1,2,5,6,7,15). This program included the collection (using the same equipment as for normal groundwater samples) and analysis (to the same extent as in the normal samples) of additional special samples (duplicate samples - 10.8% of normal samples; zero samples - 4.4% and spiked samples - 4%).

Figure 2 present hydrogeochemical background of selected main and trace compounds, determined for the Upper Vistula River Basin on the base of results from RGQM.

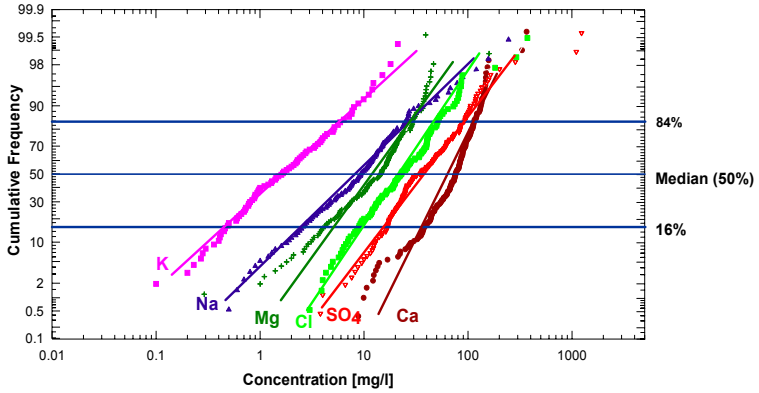

Figure 2 (a)

Hydrogeochemical background determined for the Upper Vistula River Basin on the base of results from Regional Groundwater Quality Monitoring for major compounds

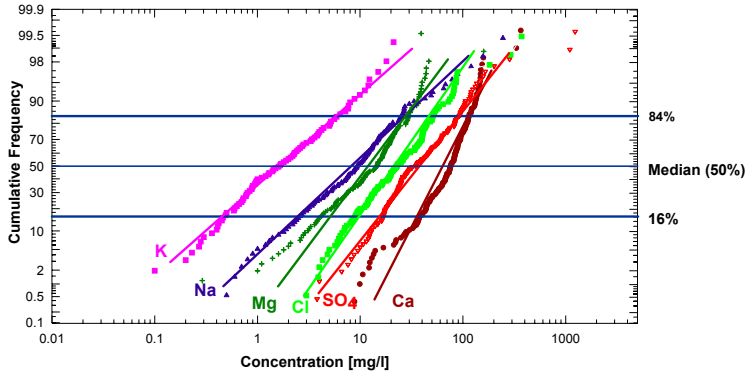

Figure 2 (b)
Hydrogeochemical background determined for the Upper Vistula River Basin on the base of results from Regional Groundwater Quality Monitoring for trace compounds

Groundwater quality in the Major Groundwater Basin 451 (Upper Vistula River Basin)
Tertiary groundwater body Bogucice 451 is located in the south of Poland, in the area of the Upper Vistula River Basin. It has area 176 sq. km and shape of basin. The main task of this groundwater body is delivering for society and individual users water (hospitals and agriculture). It has been included in the international programme Baseline (4). Monitoring network of groundwater body Bogucice consists of 33 sites. Samples were collected during two sampling series: summer/autumn 2000 – first sampling; summer 2001 – second sampling.

The range of determinations similarly how in case of Regional Grounwater Quality Monitoringu of Upper Vistula River Basin, included field analysis (5 physico-chemical indicators) and laboratory analysis (90 mineral and bacteriological indicators). For all data were determined the maximum and minimum values (in case, when the values were lower than limit of determination, to calculations was introduced half limit of determination of this component), the mean value, standard deviation and outliers. It was also calculated value of hydrogeochemical background.

In Baseline project hydrogeochemical background means the range of concentrations of a given element, species or chemical substance present in solution, being derived from natural geological, biological, or atmospheric sources**.** Precise qualification range of this background is necessary to distinguish the anthropogenical changes in groundwater and geogenic results called out with intensive exploitation of water. Additionally intensive exploitation can call out the quick changes of quality of groundwaters, range of hydrogeochemical background can be change without anthropogenical pollutions (4).

Figure 3 presents range of concentrations (hydrogeochemical background) of selected indicators (K, Na, Mg, Ca, Cl, SO_4, Zn and Fe) of groundwater quality.

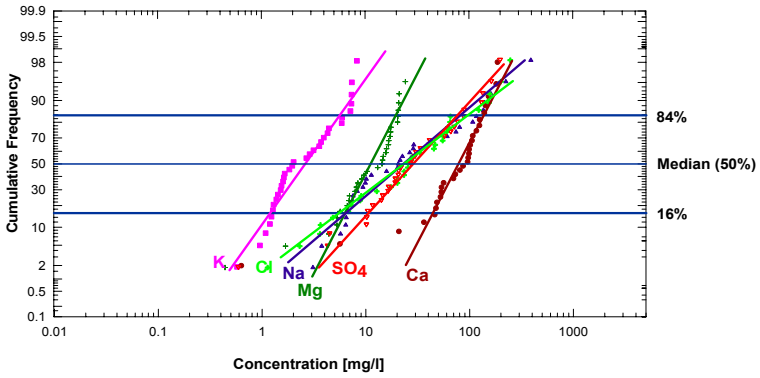

Figure 3a
Hydrogeochemical background determined for Major Groundwater Basin 451 for major compounds

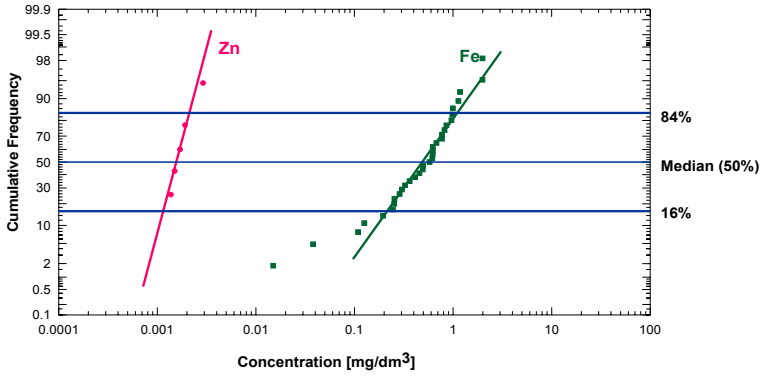

Figure 3b
Hydrogeochemical background determined for Major Groundwater Basin 451 for trace compounds

Conclusions

Table 1 presents comparison of hydrogeochemical background for the Upper Vistula River Basin and MGWB 451 with estimated for a whole Poland hydrogeochemical background (3) and standards for drinking water (MPL—maximum permissible concentration of analysed compound in drinking water according to European Union Directive 98/83/EC).

Table 1
Comparison of hydrogeochemical background for the Upper Vistula River Basin and MGWB 451 with estimated for a whole Poland hydrogeochemical background (3) and standards for drinking water (MPL—maximum permissible concentration of analysed compound in drinking water according to European Union Directive 98/83/EC)

Element	MPL [mg/l]*	Hydrogeochemical background [mg/l]		
		UVRB (172 sampling points)	MGWB 451 (33 sampling points)	Estimated for a whole Poland
Major elements				
K	-	0.35-7.0	1.2-5.5	0.5-10
Na	200	2.2-28.0	6.0-87.0	1-60
Mg	50	4.5-29.0	6.0-18.0	0.5-50
Ca	-	35.0-120.0	44.0-110.0	2-200
Cl	250	8.5-47.0	5.6-110.0	2-60
SO_4	250	13.0-90.0	9.8-80.0	5-60
Trace elements				
Fe	0.2	0.03-2.2	0.23-0.9	0.02-5.0
Zn	3	0.02-0.26	0.002-0.063	0.05-0.50

Data from Regional Groundwater Quality Monitoring show that typical values of concentration for all analysed elements don't exeed the maximum permissible levels in drinking water (according to EU Directive 98/83/EC) with the exeption of iron concentration. The values of concentration of sulphates exeed values of hydrogeochemical background estimated for a whole Poland. They result from pollution of air, influence of great municipal agglomerations and industrial.

Data from Major Groundwater Basin 451 show that determined hydrogeochemical background for Cl, SO_4 , Na and also Cl is increased in relation to background estimated for whole Poland (3). Ions Fe don't fulfill requirements of UE of drinking water.

For both cases (RGQM and MGWB) increased sulphates concentrations can be result of pollutions groundwater by the precipitations. Concentrations of sulphates in atmosphere growed up considerably in last several decades. Anthropogenical pollution on this area caused the growth of concentration Na and Cl. High concentration of this ions we observe in nort-east part of water-bearing layer groundwater body but the highest their concentration are beyond his borders. Principled cause of concentration Fe are geogenic conditions.

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