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Geochemical Atlas of Slovakia – Groundwaters, Preliminary Results

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Abstract:

Within the framework of the project "Investigation of Environmental Geofactors" 1991-1995 there has been realised the task "Geochemical atlas of Slovakia". In the part focused on groundwater, 16 300 samples (sampling density 1 smpl. per 3 sqkm) were analysed for T.D.S., pH, aggr. CO_2, SiO_2, Na, K, Mg, Ca, NH_4, F, Cl, NO_3, SO_4, HCO_3, PO_4, Fe, Mn, Li, Sr, Zn, Cu, Cd, Pb, Cr, Hg, As, Se, Tl, Sb, Al, Ba, COD - Mn. The task has been designed to provide comprehensive background information on the distribution of components and elements in groundwaters of Slovakia.

Key words: groundwater chemistry, mapping, geochemical anomalies, regional hydrogeochemistry

(3 Figs., 1 tab.)

Introduction

The project entitled "Investigation of Environmental Geofactors" (1991–1995) includes the task "Geochemical atlas of Slovakia". This task is aimed at the compilation of a geochemical atlas of the Slovak Republic, on the scale 1 : 1 mil., during the period 1991–1995, along with maps of geochemical anomalies on the scale 1 : 200 000.

The investigations are focused on the evaluation of concentrations and distributions of chemical elements, including toxic ones, in stream sediments, groundwaters, rocks, soils and forest biomass. The evaluation is aimed also at the total natural radioactivity of the territory and of the constituting elements (K. VRANA, 1992).

The co-ordinator of the project is the Dionýz Štúr Institute of Geology in Bratislava, with the participation of 10 further institutions dealing with natural sciences. From the beginning of the project, the solution of all methodological aspects has been consulted within IGCP No. 259 – International Geochemical Mapping, from 1993 IGCP No. 360 – Baseline Geochemical Mapping (A.DARNLEY, 1994).

One of the most important results of regional geochemical mapping will be groundwater chemistry, which is intended to be published as a separate volume. This paper informs on the methodology of hydrogeochemical mapping and the preliminary results. The final results will be published at the beginning of 1996.

Samples and analytical methods

Hydrogeochemical mapping is based on groundwater sampling of the first water-bearing horizon (springs, wells, drillholes) and its aim is to provide an idea of regional distribution of ecologically and hydrologically most important elements, components and parameters on quantitative basis. In the interpretation the aim is to evaluate the role of primary and secondary factors in the formation of water chemistry on regional scale. The aim is thus to provide time-limited information on the groundwater chemistry of Slovakia, taking into account geochemical criteria of water-quality interpretation.

The water was sampled into polythene bottles from objects according to valid water-sampling regulations, with appropriate adjustment to relevant laboratory requirements. Sampling density is 1 sample per 3 sqkm. Besides natural springs with large capacity, there are sampled also captured springs, dug wells and drillholes, which are used actively. It is evident that regions differ from each other as to the character of sampled objects and real sampling density, due to hydrogeological conditions of the territory.

During similar hydrogeochemical mapping (e.g. P. LAHERMO et al., 1990) groundwater samples are filtered through membrane filters. In our case, samples were filtered through 0.45 mm membrane filters.

Directly in the field all unstable components were fixed and water temperature, pH, conductivity, dissolved O_2, free CO_2 (acidity) and alkalinity were measured. Other components were determined in the laboratory.

The project assumed that a wide range of elements and components (Tab. 1) would be determined in the INGEO laboratory in Žilina, using standard methods for lower detection limits, especially in the case of metals. The control of the laboratory has been secured by the lab's participation in domestic and foreign control tests.

Tab. 1 Analytical processing of hydrogeochemical samples (ppm)

Element Component	Analytical method	Detection limit
Na	AAS-F	100,00
K	AAS-F	100,00
Mg	CT	1000,00
Ca	CT	1000,00
SiO_2	SPFM	500,00
NH_4	SPFM	50,00
F	ISE	100,00
Cl	T	100,00
NO_3	ITPH	500,00
SO_4	ITPH	300,00
HCO_3	(A-B)T	100,00
PO_4	SPFM	50,00
Fe	AAS-F	5,00
Mn	AASF	5,00
Li	AAS-F	2,00
Sr	AAS-F	10,00
Zn	AAS-F	1,00
Cu	AAS-ETA	0,50
Cd	AAS-ETA	0,.50
Pb	AAS-ETA	1,00
Cr	AAS-ETA	0,50
Hg	AAS-CV	0,20
As	AAS-MHS	1,00
Se	AAS-MHS	1,00
Tl	AAS-ETA	5,00
Sb	AAS-MHS	0,20
Al	ICP-OES	10,00
Ba	AAS-F	100,00

AAS-F: flame atomic absorption spectrophotometry, CT: complexometric titration, SPFM: spectrophotometry, AAS-CV: atomic absorption spectrophotometry - cold vapour, AAS-MHS : atomic absorption spectrophotometry - mercury hydride system, (A-B)T: acid-base titration, T: titration, ISE : ion-selective electrodes, AAS-ETA: atomic absorption spectrophotometry-electrothermic atomisation, ITHP: isotachophoresis

Tl has been omitted during the work on the project from the studied association, since Tl has not been determined in amounts above the detection limit in any of the first 3000 samples.

Preliminary results and discussion

The results are interpreted by a team of authors of the co-ordinating institution. The basis will be the compiled maps, a detailed mathematical-statistical data analysis, systemisation diagrams, and hydrogeological as well as hydrological knowledge of the Slovak territory will be taken into account too.

The basic input of the interpretation part will be the text of explanations of Geochemical Atlas, part Groundwater, which, besides newly obtained data, will summarise also important available results of hydrogeochemical mapping of the regions on the Slovak territory. It will include also available information obtained from groundwater quality monitoring project on the Slovak territory.

The Geochemical Atlas will be constructed on the scale 1 : 1 000 000, the geochemical-ecological maps on the scale 1 : 200 000. A part of the obtained information will be displayed in additional maps on various scales.

Geochemical data will be presented in the atlas as follows:

- single-element coloured maps constructed on the principle of moving median (moving median maps) - they will represent regional variations of element contents
- single-element black-and-white point maps (e.g. display of absolute element concentrations, from which over 75% are below detection limit).
- derived maps of various types, if required (e.g. combination of single-element coloured maps with superimposed points representing element contents or ratios, etc.)

Examples of the above basic types of graphic presentation are shown on Figs 1, 2, 3.

Another type of output in the Geochemical Atlas of Groundwater are association geochemical-ecological maps on the scale 1 : 200 000. In these maps anomalies of hydrogeochemically and ecologically important elements including toxic metals will be presented in additive form.

The basis (standard value) are concentration limits from the drinking-water standard and "B" values of water pollution indicators and normatives.

With the aim of obtaining a more complex information on natural waters in Slovakia, some further

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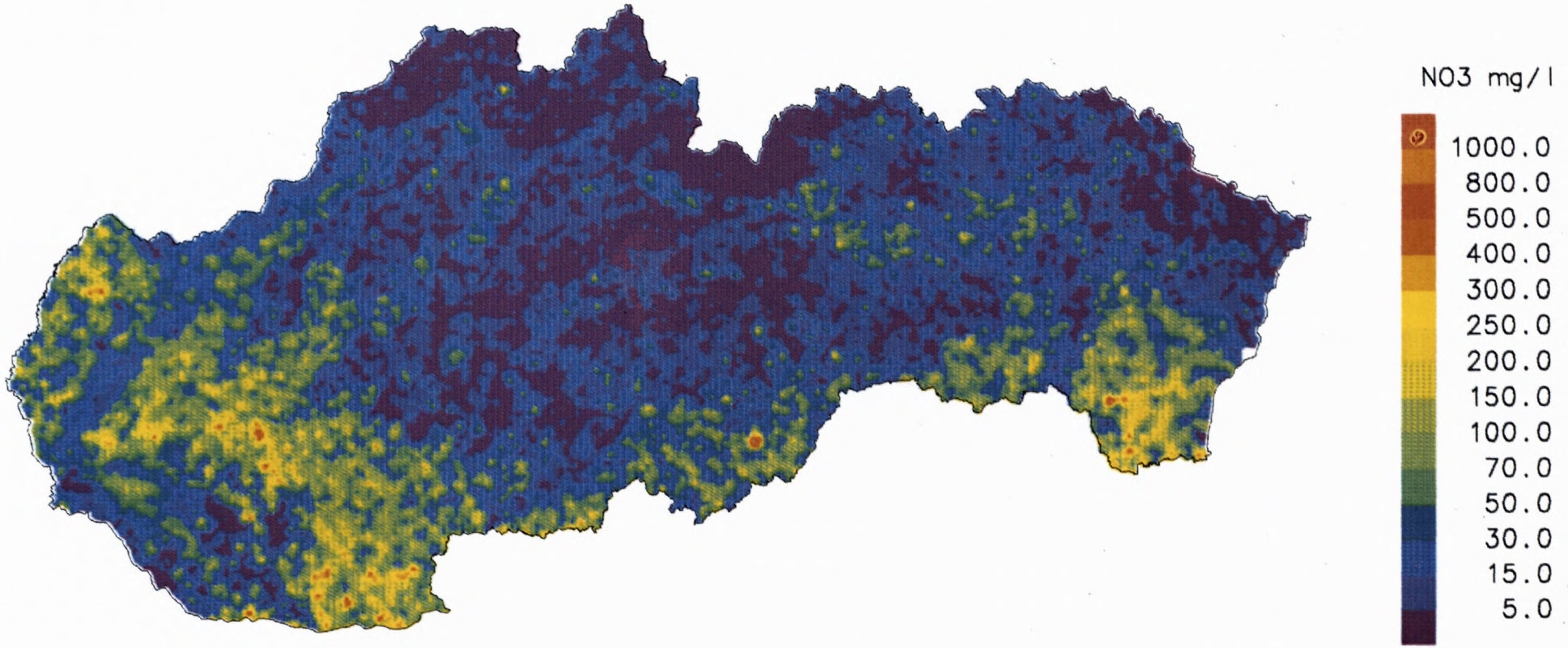
The Geochemical Atlas of Slovakia, Groundwater

SCALE 1:2 000 000, number of samples: 16 392



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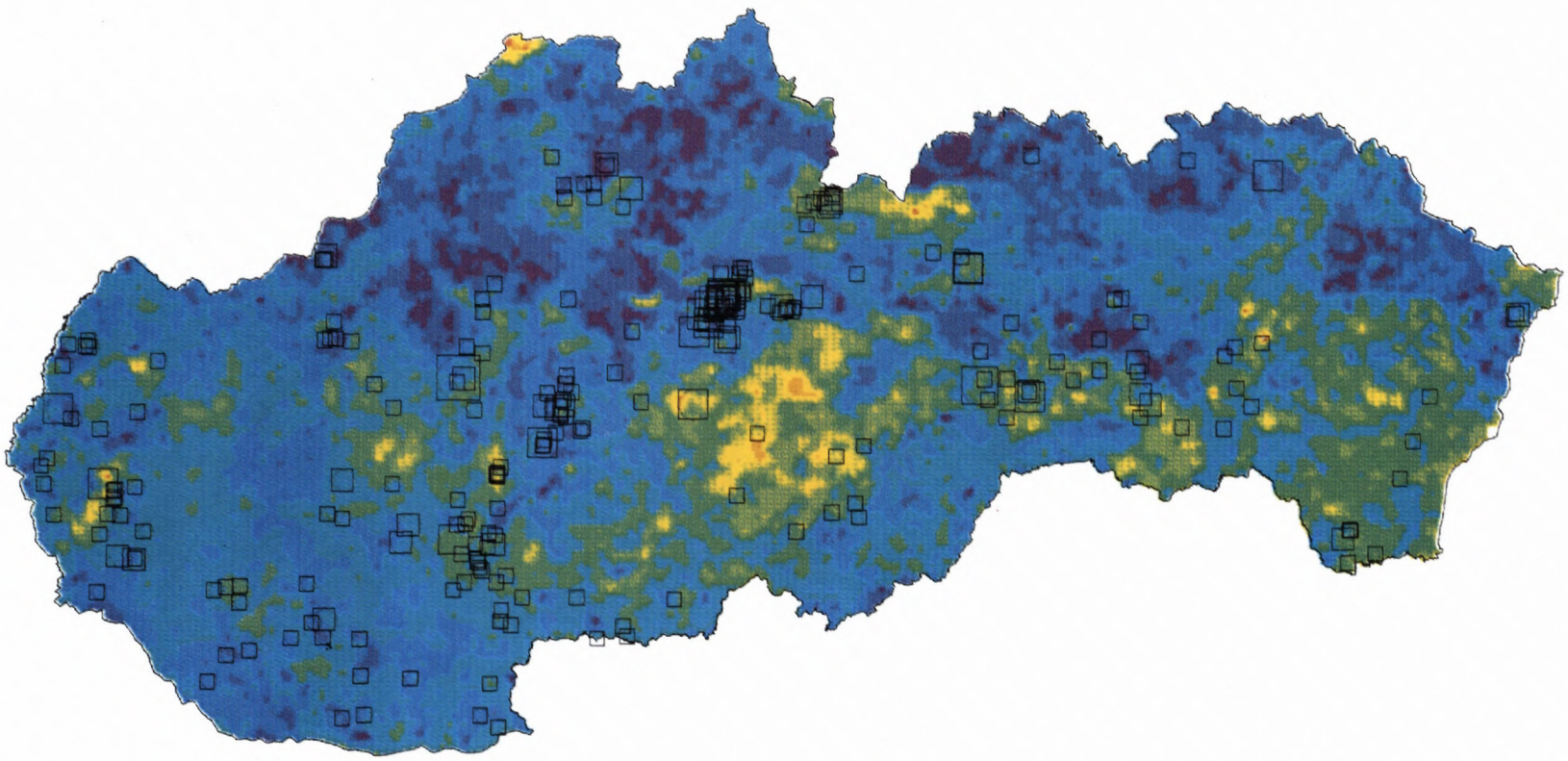

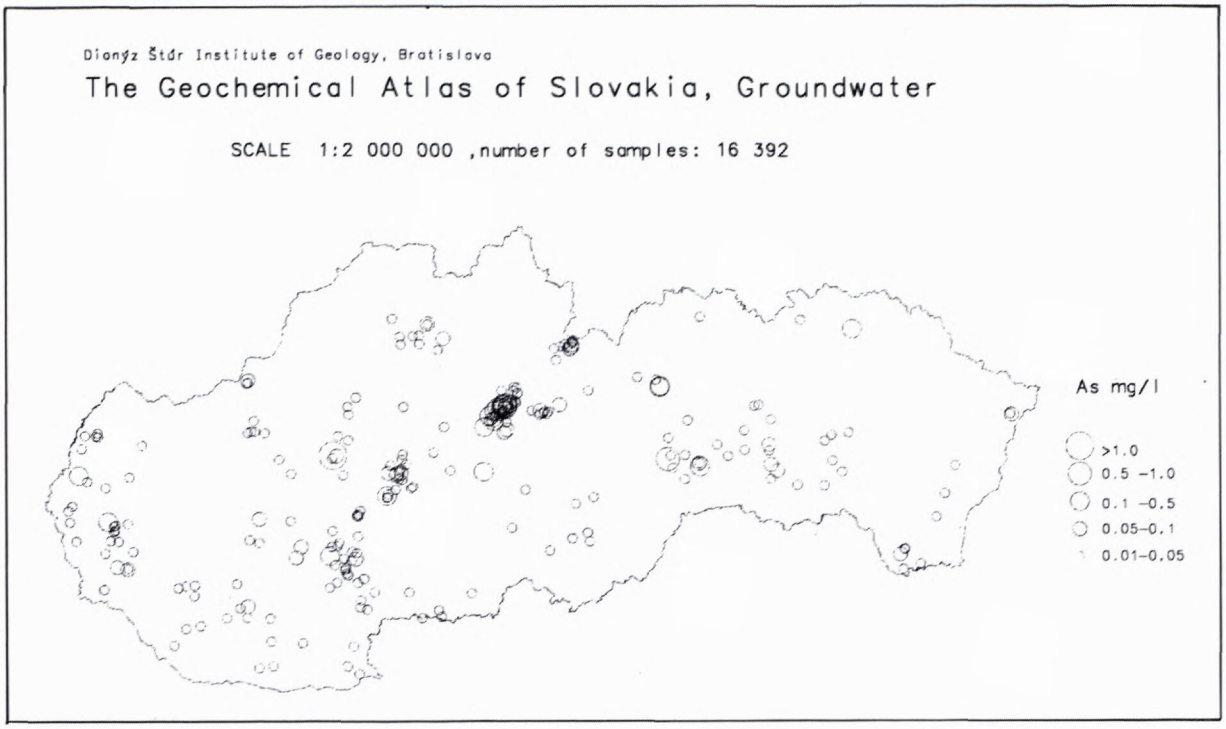

characteristics of natural water in Slovakia will be described and presented in the Geochemical Atlas in the form of additional maps, e.g. chemical composition of winter precipitation (snow) and natural radioactivity of groundwater (Rn^{222}, Ra^{226} and U^{238}).

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