
REVIEWS

The Review of the Atlas—Book Geochemistry of European Bottled Waters

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Underground waters as one of the sources of water resources for solving the problem of providing the population with drinking water have acquired a rather great significance for many countries of Europe and the world. For instance, in Ukraine underground sources account for some 30% of water yield for household-drinking water supply. Underground water, as more protected from pollution, are used for the production of bottled waters, whose role as a main dominant source of drinking water for the population in many European countries every day increases.

At the same time, starting from the second half of the 20th century against the background of the disastrous changes in the quality of the environment, deterioration of the ecological state of surface and underground sources, the problem of monitoring the quality of water used by people for drinking purposes becomes ever acute. As a result of its low quality real threats of the sanitary-epidemiological situation do emerge in different regions of the planet. In the context of these problems the atlas—book (Reimann&Birke(eds.) *Geochemistry of European Bottled Water*, 2010.XII, 268p., 28 fig., 6 tabl., 2app., 67 element maps, data CD, ISBN 978-3-443-01067-6) put out by Borntraeger Science Publishers (Stuttgart, Germany) in December 2010 draws great interest. It includes 9 chapters including the introduction and conclusions, the bibliographical list, applications and a CDD-ROM containing data base of the atlas.

The authors of the book has used the original and sufficiently interesting approach to the assessment of the chemical quality of Europe's underground waters by the analysis of the chemical composition (inorganic components) of bottled waters, which are sold for drinking in various countries of the European continent. At present, in Europe approximately 1900 trade marks of the so-called “mineral waters” have been officially registered. These waters are produced for drinking purposes and all bottled water is the water from underground sources. The data on the composition of the bottled water, which was on sale in 2008–2009 in 40 countries of Europe—from Portugal to Russia including Ukraine are behind the atlas planning. It is important that all samples of the water were analyzed in one laboratory on more than 70 indicators using modern analytical methods and in compliance with European standards. All in all 1785 samples of bottle water from 1247 wells of 884 localities and also 500 samples of tap water (2008).

The introduction (Chapter 1) contains substantiation of the chosen conceptual approach, in this case it is very important, that real complications, related to its implementation, are discussed as well as possible reasons making it possible to talk about poor representationism of a number of obtained data. In addition, a brief information is given on what underground waters are, what the terms “bottled water”, “mineral water”, “spring water”, “table mineral water”, and “medicinal water” mean and besides information is given on the requirements of the effective European legislation and international standards (WHO, FAO, Codex, US EPA) for mineral drinking waters.

Chapter 2 of the atlas—book deals with a brief description of the hydrochemistry of underground waters and factors affecting the formation of their chemical composition.

The initial data of the European continent—topography, geology, mineral fossils, the hydrological map of Europe, soils, vegetation, and the use of lands, climate and human activities are given in Chapter 3.

The book's Chapter 4 contains the description of the analytical part of the completed research: the procedure of selection and preparation of water sampling for the analysis, analytical techniques (ICP-GMS, ICP-AES analysis, atomic-fluorescent spectroscopy, ionic chromatography, photometric analysis, titration, potentiometry and conductometry), quality control, detection limits, international standard samples, etc. The results of comparison of the obtained data of the analysis of water samples with the information given on the

labels of bottled waters are interesting in the practical viewpoint. An important part of the given chapter seems to be the material dealing with the discussion of possible issues (the impact of different methods of water treatment, etc.) in the use of obtained information on bottled water for the formulation of the conclusion about the fact whether they provide a real picture of the real quality of underground water and whether they are capable of reflecting "geology".

Chapter 5 briefly describes the electronic data base, which were obtained on bottled waters, the European tap water and also earlier published data base on the composition of European surface waters (The FOREGS Geochemical Atlas of Europe Surface Water, 2005) and mountain underground waters of Norway (Frengstad B. et al., 2000, Science of the Total Environment, 246, pp. 21–40) given in the CD-ROM attached to the book.

Chapter 6 gives the results of the comparative analysis of the composition of bottled waters (by 69 elements/indicators) with the composition of the samples of the European tap water, European surface waters and underground waters of Norway. In this case a general conclusion is made that along with a number of exceptions, the samples of bottled waters in terms of mean values and their spreading secure a representative idea about the quality of European water.

Chapter 7 is a key one since it shows concentration maps of the European continent by every indicator/element (electric conduction, pH, alkalinity, Ag, Al, As, B, Be, Bi, Br⁻, Ca, Cd, Ce, Cl⁻, Co, Cr, Cs, Cu, Dy, Er, Eu, F⁻, Ga, Gd, Ge, Hf, Ho, I, K, La, Li, Lu, Mg, Mn, Mo, Na, Nb, Nd, NH₄⁺, Ni, NO₃⁻, P, Pb, Pr, Rb, Se, Si, Sm, Sn, SO₄²⁻, Sr, Ta, Tb, Te, Th, Tl, Tm, U, V, W, Y, Yb, Zn, Zr) with explanations and discussion of the features being observed on maps and informations on the normalization of the contents of these elements by the European standard for drinking water.

Chapter 8 is dedicated to the analysis of the aftermath for human health of consumption of drinking water containing these or other elements in the context of normalizing their contents to the standards of the European Union (EU Directive 2003/40/EC Mineral Water, Directive 98/93/EC) WHO and individual countries and also based on the obtained data base on the water composition. The given book discusses those indicators for which maximum allowable concentrations are set as well as a number of indicators, which are not standardized, but may affect human health. In this case the book's authors draw attention to the fact that the field of vision did not include the analysis of the water composition in terms of organic components and the presence of pathogenic organisms whose role from the viewpoint of water safety for human health, when compared with inorganic indicators, is not less important and sometimes even more important.

General conclusions by the results of the conducted research are set out in Chapter 9. In this case we would like to note that the authors realized their concept and the data given in the atlas–book on bottled waters may be used for the formation of the first idea about natural transformations of analyzed elements in the waters in the scales of Europe. It has been found that natural variations of concentrations are great and constitute 3–4 orders of magnitude and in some cases 7 orders of magnitude. It is important, that from the viewpoint of meeting the European standards for the water it was true for most of studied samples. At the same time the authors of the book believe that for rather large amount of elements in terms of their impact on human health, a special attention should be given to boundary values of concentration ranges.

Thus, the book Geochemistry of European Bottled Waters on the whole deserves a positive assessment and is of a considerable interest both for experts working in the field of geochemistry, hydrochemistry, standardization, water treatment, and preparation of drinking water, production of bottled water and for inhabitants of the European continent using bottled water as a constant source of drinking water.

However, analyzing the materials of the book one may express a deep regret that for the conduction of such wide-scale research, within the framework of the European continent, of bottled waters and tap water for drinking purposes fundamental approaches to the assessment of drinking water quality were not used, which were developed in Ukraine for the last decades (Goncharuk, V.V., *Khimiya i Tekhnologiya Vody*, 2008, special issue, part 2, pp. 52–111; Goncharuk, V.V., *ibid.*, pp. 112–125; Goncharuk, V.V., *ibid.*, 2010, vol. 32, no. 5, pp. 463–512) whose results were the development of the State Standard of Ukraine for Drinking Water.

The new Standard of Ukraine, in fact, includes three standards:

- GOST Standard for tap water (potable water);
- GOST for drinking water of the higher quality (the water absolutely safe for human health);
- GOST for bottled water.

This Standard should be extended to all economic entities producing drinking water by way of centralized water supply or by means of water pouring points (including pump rooms points and movable ones), the use of plants, other means of non-centralized water supply, and the bottling of drinking water. In developing the Standard with respect to regulatory requirements to the water of the centralized drinking water supply general

provisions and regulatory requirements to the quality of drinking water, which are accepted in the European Union, the WHO, the Codex Alimentaris, etc. were taken into account.

The first fundamental difference of this Standard is a normative substantiation of a new conceptual approach to water supply of Ukraine's population with quality drinking water providing for sparing water supply by differentiation of standards for the drinking water supply into physiological, sanitary-hygienic, and household human needs for one twenty-four hour period in a specific locality.

The second fundamental difference of this Standard is the fact that the main emphasis was made on new approaches to the assessment of the quality of drinking water by integral indicators of water toxicity, which is established by the methods of biotesting by standardization techniques. It makes it possible to obtain an objective piece of information on the quality of drinking water before carrying out a detailed analysis by all indicators. Such an analysis is expedient in the case of detecting toxicity and necessity of finding causes of its emergence.

The third fundamental difference of this Standard is the requirement of a complete absence of all toxic chemical and biological contaminants in drinking water intended for consumption by man. It includes fundamentally new and very effective integral methods of water quality control (Arkhipchuk, V.V. and Goncharuk, V.V., *Khimiya i Tekhnologiya Vody*, 2001, vol. 23, no. 5, pp. 531–544; Arkhipchuk, V.V. and Goncharuk, V.V., *ibid.*, 2004, vol. 26, no. 4, pp. 404–414; Goncharuk, V.V., et al., *Visnyk NAN Ukrainy*, 2005, no. 3, pp. 47–58). The proposed integral methods of biotesting are intended for detecting acute toxicity at the level of organism and chemical toxicity at the cellular level using for this purpose cytogenetic methods on biological objects. These methods are universal for all kinds and types of toxic compounds irrespective of their origin and nature of actions.

We have conducted a complex assessment, by the degree of toxicity, of drinking bottled non-gassed waters most spread in Ukraine and Russia by four categories: safe, unsafe (reverse toxicity), dangerous and very dangerous (toxic) water (table). In the waters Gornaya Verzhina and tap water, acute toxicity revealed itself at the level of organisms whose death did not make it possible to assess cytogenic deviations.

In the context of the book being reviewed in conjunction with the fact that, as a rule, bottled water is stored for more than one month, they are subjected to preservation. The preservatives used are toxicants dangerous for human health. At the same time the absence of a preservative in bottled water inevitably result in the development of anaerobic microflora and dramatic increase of the toxicity of such water. Therefore, the integral methods of biotesting of bottled waters acquire a special significance.

The use of the methods of assessing the quality of drinking water by integral indicators proposed by us make it possible within short time and the smallest economic costs to estimate the suitability of drinking water for human consumption.

Complex assessment of drinking bottled waters (31 brands) by cyto- and genotoxic indicators

Nos.	Brand of bottled water	GI (genotoxic indicators MN‰)	GI (genotoxic indicators 2N‰)	CI (cytotoxicity index)	Nos.	Brand of bottled water	GI (genotoxic indicators MN‰)	GI (genotoxic indicators 2N‰)	CI (cytotoxicity index)
1	Morshins'ka	0	0	2.21	17.	Svyatoi istochnik*	0.33	2.01	14.16
2	Simeina	0	0.33	2.65	18.	Sofiya Kyivs'ka	0.99	1.33	16.11
3	Bonaqua*	0	0.33	3.09	19.	Prozora	0.33	2.01	16.14
4	St.Myrgorod	0	0.33	3.98	20.	Shishkin Les*	1.66	1.33	16.24
5	Arkhyz*	0.33	0	3.09	21.	Senezhskaya*	0.99	2.34	16.23
6	Waterhall-Selen*	0	0.66	3.94	22.	Doktor	1.67	2.34	18.14
7	Aqua minerale*	0.33	0.33	3.98	23.	Aqua-areal*	1.67	2.67	20.61
8	Waterhall*	0	0.99	5.70	24.	Kalipso	1.67	3	20.35
9	Roka-dovskaya*	0	0.66	7.52	25.	Humana	1.67	3	20.35
10	Ordana	0.33	1	10.33	26.	Novoterskaya gornaya*	1.67	3	23.25

Table. (Contd.)

11	Voda pytna	0.66	0.99	10.48	27.	SPA	2.01	3.66	22.14
12	Bebivita	0.66	0.99	10.56	28.	Znamenivskaya	2.01	3.66	22.12
13	Vitel	0.33	1.67	10.62	29.	Pilgrim*	2.34	4	28.07
14	Hipp	0.67	1.34	11.75	30.	Contrex	3	4	27.34
15	Demi-dovskaya*	0.99	1.33	11.40	31.	Gornaya vershina*	Tests organisms	Died	
16	Pushkar-skaya zhivaya*	0.99	1.33	11.84	32.	Tap water	Test organisms	Died	

Note: * The water brand made in Russia. White zone “Safe waters” category meets the requirements of high-quality drinking waters. Light-gray zone the “Unsafe waters” category causes cytogenic changes in the cells of test organisms. Undesirable for use as a drinking water. Gray zone the “Dangerous waters” category is irreversible toxicity exerts a strong cyto- and genotoxic effect on test organisms. Not suitable for drinking consumption. Black zone, the “Very dangerous toxic waters” category exerts a strong cyto- and genotoxic effect on test organisms. Not suitable for drinking; MN—micronucleoli.

Based on the above, I believe it is expedient to recommend that the international community consider the possibility of using new fundamental approaches to the assessment of the drinking water quality by the method of biotesting developed in Ukraine and the introduction of the integral method of biotesting to the International Standards. Our proposals are backed by the fact that the control of more than 40 million of different chemical compounds, known to date in the world, which were obtained mainly in the pharmaceutical and agroindustrial sectors (annually more than 2 million new compounds are synthesized), does not seem possible since synergism of the action and the processes of biodegradation are unpredictable.