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CHEMICAL CHARACTERIZATION OF POTABLE MINERAL WATERS

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Abstract

This article discusses chemical characteristics of Serbian natural mineral waters in comparison to worldwide-recognized waters. The attempt has been made to range mineral waters in respect to the calculated statistical line of mineralization. A moving average method was adopted for the calculation of statistical representative points for the main ions content of mineral waters. Proposed mode for characterization specifies the pathway from low to high mineralized water accompanied with the changes in water chemical composition.

Introduction

In the Food Safety Act 1990 [1] water is included as a food where it is used as a drink or as a food ingredient. Generally, mineral water contains at least 250 mg/L total dissolved solids (TDS), comes from a source tapped at one or more boreholes or springs, and originates from a geologically and physically protected underground water source. Records of mineral water exploitation in Serbia date as far back as in 1719 and the sale of bottled water has continuously increased and reached up 388.202.000 liters in 2002.

Due to surface speciation and dissolution kinetics in aqueous solutions, waters are not necessarily uniform throughout a particular geological formation, but often the waters of a particular district have much resemblance to each other. It is not know with any certainty the depth from which various mineral waters proceed, nor the various distances from the surface at which they take up their different mineral constituents from neighboring rocks. The aim of this paper was to find the pattern for the most frequent cation and anion combinations in mineral waters as the result from the rock formations, through which the water flowed.

Results and Discussion

Most of Serbian waters occur predominantly in geological setting of crystalline schists of different degree of metamorphism [2]. They are highly saturated with CO_2 likely of magmatic origin. Main features of potable waters are in a wide range of pH values (6.5 - 8.5) and TDS (52 – 2800) mg/L as the dry residues at 180^{o}C what is commonly considered satisfactory [3]. The characteristic (pH, bicarbonate, and concentration of bioelements Na, Ca, K, Mg, F, Cl, and SO_4) of mineral waters of Serbian origin exhibit frequency distributions similar to 1500 waters of worldwide recognized supply. The presence of dominant ions (bicarbonate and carbonate) and cations (Na and Mg) is obvious indicating the lime rock water-bearing layers. Usually, the fluoride

concentration is low except in some case when it reaches up to 6 mg/L (*Aqua Heba)*. Our mineral waters are pretty drinkable because of depleted sulfate concentration that makes bitter taste. As the consequence, a very poor content of important bioelement selenium, which follows sulfur chemistry, was noted.

In the present study we calculated the statistical line of mineralization, SLM, (how much minerals the water carries) as the average of 1500 mineral waters of the world sorted by TDS. A moving average method was applied for the calculation of statistical representative point for the main ions content of mineral waters

$$\overline{X_j} = \sum_{i=100j}^{i=100j+99} \frac{x_i}{100}, j = 0,1,2,...,N$$

where x_i is a concentration of ionic species and $\overline{X_j}$ determines the point on SLM as the mean value of 100 analyzed waters. SLM represents the global most probable anion-cation ratio for particular mineralization. It is shown together with available Serbian potable waters in Piper diagram [4] (Fig. 1) where mole equivalent fraction of anions (Cl^-, SO_4^{2-}, HCO_3^-, and CO_2^{2-}) and cations (Na^+, Ca^{2+}, K^+, and Mg^{2+}) are presented on the trigonal coordinate axes. The thickness of crosshatched line correspondents to magnitude of mineralization. In addition, the mean value of mineralization for both 1500 worldwide waters and for 15 Serbian commercially available waters is drawn. Most of our bottled mineral waters are close to SLM except *Mivela* water due to its relative high content of Mg in respect to Ca.

Conclusion

In spite of the differences, the Serbian waters are mostly typified by their HCO_3-Na, and Mg content. We followed the general rule for classification of water under the head of its predominant elements. The proposed mode uses TDS as a guideline for understanding the relative cation-anion content for the particular water. The calculated statistical line of mineralization specifies the pathway from low to high-mineralized water accompanied with the changes in chemical composition.

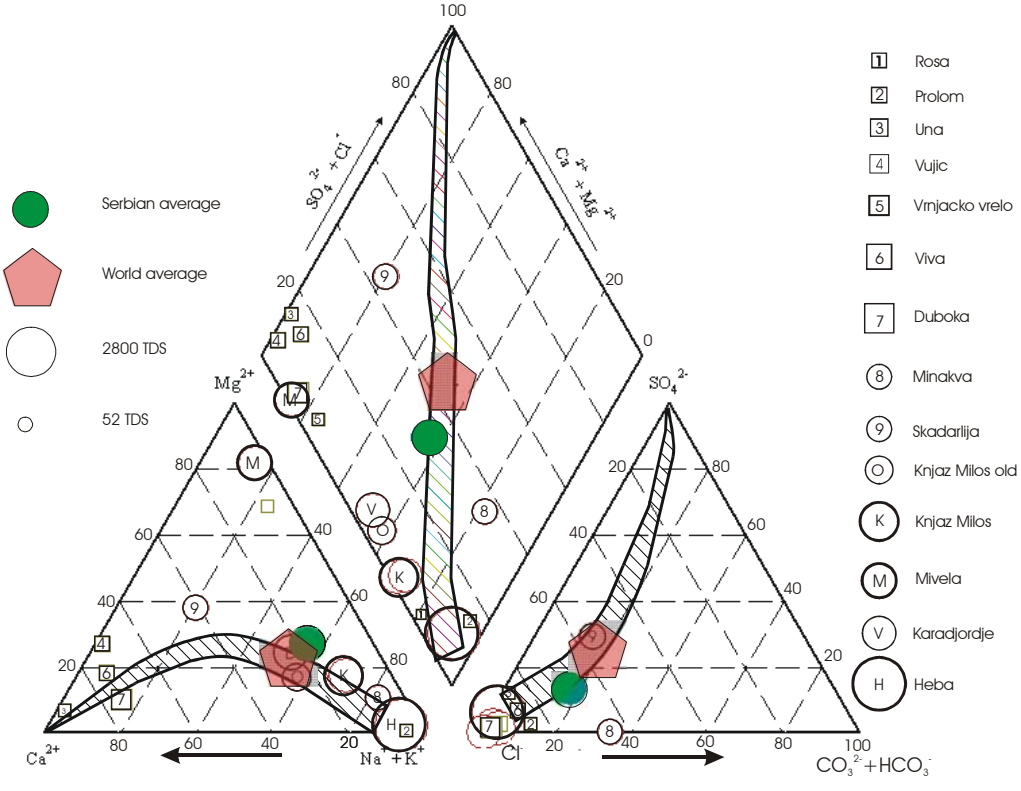

Figure 1. Piper diagram for the considered mineral waters

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