

OCCURRENCE AND UTILIZATION OF THE MINERAL WATERS OF SZCZAWA, KROŚCIENKO AND SZCZAWNICA (PRELIMINARY DATA)

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Abstract: Mineral and therapeutic waters are numerous in the Polish Carpathians. Based on the presence of geochemically diversified types of water, three horizontal hydrochemical zones of their distribution have been distinguished: central, transitional and outer. The waters of Szczawa, Krościenko and Szczawnica are associated with the transitional hydrochemical zone. They represent carbonated waters and waters containing carbon dioxide and are available either in natural springs or from boreholes or dug wells. The geochemical type of all the waters of this region is hydrocarbonate, and chloride is the second dominating anion. Free CO₂ is the most characteristic and important component; significant is the presence of specific components: iodides, bromides and borates. The waters are utilized in balneotherapy mainly in the Szczawnica spa.

Key words: the Carpathians, carbonated water, water containing carbon dioxide, therapeutic water

INTRODUCTION

Mineral waters, namely carbonated waters, chloride waters (brines), and sulphurous waters, as well as thermal waters are the main resources of the Carpathians. The diversification of the mineral waters in the Outer Carpathians is expressed in the horizontal and vertical zoning of their distribution. Three horizontal hydrochemical zones were distinguished: central, transitional and outer (Węclawik 1967). The authors have characterized mineral waters of Szczawa, Krościenko and Szczawnica, which - according to regional division of the mineral and therapeutic waters of Poland - occur within the Carpathian province D, in its Outer-Carpathian region DII, and in the Poprad sub-region DII1 (Paczyński & Płochniewski 1996).

GEOLOGICAL SETTING

The mineral waters described occur in the S part of the Magura Unit of the Outer Flysch Carpathians. The strata of the Magura Unit represent the profile from Middle Jurassic to Lower Oligocene. They were deformed in Upper Cretaceous-Paleocene, Eocene, and in Lower and Middle Miocene. The Magura Unit was detached within the middle and upper Cretaceous strata. Close to the Pieniny Klippen Belt, the bottom of the Magura Unit is situated at a depth of below 10 km.

The mineral waters of the Krościenko and Szczawnica region occur within the Krynica sub-unit of the Magura Unit. This region is composed mainly of the folded strata of the Szczawnica Fm., Zarzecze Fm. and Magura Fm. They contact with the Pieniny Klippen Belt along an almost vertical, longitudinal strike-slip fault. The springs and water intakes in the region are associated with hypabyssal andesite intrusions, occurring in the Magura and Grajcarek units (Birkenmajer 1992). The volcanites were emplaced as sills

and dikes during Miocene, i.e. in the Carpathian, Badenian, Sarmatian (Birkenmajer & Nairn 1969). The presence of carbon dioxide is linked just with this volcanic activity.

The mineral waters in the Szczawa village region occur within the strata of the Dukla Unit, i.e. the Menilite and Krosno beds (Chrzastowski 1971, 1992). The rocks are exposed in a small Szczawa tectonic window (about 1.5 km²), and are surrounded by the Cretaceous-Paleocene strata of the Bystrica (Nowy Sącz) Sub-unit of the Magura Unit. The rocks in question belong to the Poręba and Kanina beds, Szczawina sandstones and Szczawnica Fm. (Inoceranian Beds). The Szczawa tectonic window is bordered by faults or overthrusts, and its strata form an asymmetric anticlinal structure. The Magura Unit strata form a secondarily folded brachyantyclinal structure (Oszczypko *et al.* 1991).

HYDROCHEMICAL ZONES OF THE CARPATHIANS

The central zone encloses the Poprad valley and orographically right-side tributaries of the Poprad, river between Piwniczna in the west to Tylicz in the east, and includes the localities of Łomnica, Wierchomla, Żegiestów, Muszyna, Złockie, Jastrzębik and Krynica. The waters of this zone are characterized most often by mineralization (TDS content) of about 6.2 g/dm³, with a distinct prevalence of Ca²⁺ and Mg²⁺ cations, less frequently showing higher Na⁺ contents and a constant but small amounts of Fe²⁺. The anions are represented exclusively by HCO₃⁻, and Cl⁻ occurs only in traces. These waters show the presence of free CO₂, whose amounts reach 3 g/dm³.

The transitional zone is situated outside the central zone and extends from Szczawa in the west to Krościenko, Szczawnica, Wysowa, Iwonicz to Rymanów. The waters of this zone are more mineralized, about 7–10 g/dm³ on the average. According to the general rule, their mineralization increases with the depth. Among cations Na⁺ clearly dominates, and Ca²⁺ and Mg²⁺ are subordinate. Among anions HCO₃⁻ prevails, but also Cl⁻ is being noted in substantial amounts. Besides these major components, the waters contain specific components, i.e. J⁻ and Br⁻. Carbon dioxide, in amounts up to 2.5 g/dm³, is a characteristic component of the transitional zone waters, likewise it has been mentioned in the central zone waters.

The outer zone includes the remaining part of the Magura Unit as well as the Silesian and Subsilesian units. The waters of this zone have their chemical composition similar to the waters of the transitional zone but are devoid of the characteristic components, i.e. of CO₂. Their mineralization is 17-42 g/dm³, being higher than in the two former zones. Na⁺ and Cl⁻ ions are strongly dominant here, while iodine and bromine are specific components. These waters represent mainly chloride waters and brines.

Hydrogeological regime of the Inner Carpathians (the Tatra Mountains and the Podhale region) is different from the pattern mentioned above as borehole data indicate, and has not been dealt with here.

THE WATERS OF SZCZAWA

Szczawa is a holiday resort, localized in the NE part of the Gorce range in the Beskid Wysoki, in the valley of the Kamienica river and its tributaries: Mogielnicki, Głębieńiec and Szczawski streams. Situated at an altitude of 510-550 m asl, Szczawa is surrounded from all parts by elevations of the height 700-900 m asl. Such morphology controls climate conditions that show the features of the mountain climate with excellent insolation.

The mineral waters of Szczawa have been known for a long time, and the first data reach back to the 13th and 14th centuries. In 1933 a small pump-room and a small bottling plant were erected. The mineral waters were utilized on the spot in drinking treatment during summer seasons, and after bottling were distributed to pharmacies and mineral water depots in Poland. At the moment the waters of Szczawa are not properly utilized, although in 1990 they were classified as therapeutic waters. Szczawa fully deserves the status of a health resort.

The waters of the Szczawa area belong to the carbonated waters and waters containing carbon dioxide. They are available in numerous springs and made accessible *via* boreholes (Chrzastowski 1971, 1992). All of them represent the hydrocarbonate type, the next most abundant anion being Cl⁻; among cations prevails Na⁺ and sporadically Ca²⁺. Mineralization is in the range 1-28 g/dm³, and the CO₂ content reaches 2.4 g/dm³. As the specific components there occur iodine, bromine and boron. General admissible volume of extracted water amounts to 2.53 m³/h.

THE WATERS OF SZCZAWNICA

Szczawnica is a well-known spa, situated at the foothill of the Pieniny Mountains at the altitude 440-520 m asl in the valley of the Grajcarek stream, a tributary of the Dunajec. The locality has a mild, submontane climate with high insolation. The oldest pieces of information about the mineral waters of Szczawnica come from the 16th century, the health resort activities were initiated in the second half of the 18th century and have been developing since (Birkenmajer 1956, Poprawski & Józefko 1995).

In the area of the Szczawnica Spa there are springs of low discharge, boreholes reaching a depth of several tens of meters, and some other near-surface intakes.

The waters of Szczawnica represent mainly carbonated waters and waters containing carbon dioxide, with mineralization 2.9–26 g/dm³ and the CO₂ content 0.8–2.1 g/dm³. They represent the hydrocarbonate geochemical type, the second dominating anion being Cl⁻; Na⁺ is the major cation. Specific components include: J, Br and B. Total admissible volume of extracted water amounts to 2.12 m³/h, available in 11 intakes.

All of the waters have been classified as therapeutic and are utilized in balneotherapy in several sanatoriums belonging to the Uzdrowiska Szczawnica S.A. (Szczawnica Spas Co.). The waters are also bottled under trade names “Szczawniczanka”, “Jan”, “Stefan” and “Helena”.

THE WATERS OF KROŚCIENKO

Krościenko is situated in the valley of the Dunajec river about 4 km downriver from Szczawnica, at the mouth of the Krośnica stream, at an altitude of 420 m asl. Krościenko is a well-known climate resort with a healthy, mild climate and beautiful localization. The beginnings of the spa date back to the first half of the 19th century, baths and a bottling plant were constructed in 1922.

At present in the Krościenko area several springs of mineral water have been recorded. These are carbonated waters and waters containing carbon dioxide with mineralization 0.4–9 g/dm³ and the CO₂ content up to 2 g/dm³. All the waters are of the hydrocarbonate type, with the second anion represented

by Cl⁻; among cations Na⁺ prevails and is followed by Ca²⁺. An admissible volume of extracted water amounts to 0.13 m³/h.

In the Szczawnica and Krościenko area several springs of sulphurous waters were recorded. Their discharges are minor and the springs have not been utilized (Rajchel 2000).

GENESIS

The carbonated waters and the waters containing carbon dioxide of the Carpathians owe their existence to geological structure. They are associated exclusively with zones of tectonic disturbances, mainly with disjunctive dislocations. Cracks, fractures and folding structures facilitate accumulation and transport of two essential components of the carbonated waters: water itself and carbon dioxide. The genesis of CO₂ is still disputable. In the Carpathians carbon dioxide is a deep-seated gas, unconnected with the water which it saturates (Świdziński 1972, Bogacz *et al.* 1975, Leśniak & Węclawik 1984, Chrzastowski 1992). It could have originated by degassing of the Tertiary andesites or can be associated with some other volcanites of the Carpathian basement (Świdziński 1972, Birkenmajer 1956). On the basis of isotope investigations other authors linked the CO₂ with degassing of the upper mantle. Another hypothesis includes a connection of the CO₂ with low-temperature metamorphic processes (Lis & Hałas 1980, Dowgiałło 1980, Leśniak & Węclawik 1984, Zuber 1987).

The origin of the chloride and sodium ions as well as of iodides, bromides and borates (chloride waters) is also disputable. Their presence was ascribed to relict waters or to mixing of infiltration and paleoinfiltration waters and waters derived from clay minerals by dehydration (Dowgiałło 1973, Dowgiałło & Leśniak 1980, Leśniak & Dowgiałło 1986). The most recent investigations (Zuber & Grabczak 1985, 1987) assumed the chlorides themselves to be a result of mixing of infiltration and paleoinfiltration waters and waters released from clay minerals during low-temperature metamorphism.

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