

ratios towards the higher-silica compositions reflect typical magmatic trends with zircon fractionation and enhance the close geochemical resemblance of the granite intrusions. All of them display volcanic-arc and collision-related affinity according to the most popular discriminations based on incompatible trace elements. The isotopic data available support granite magma generation from predominantly igneous precursors of mixed mantle-crust characteristics.

On the other hand the granite intrusions show remarkable geochemical similarities with in situ formed anatectic melts from the CRMCC diatexitic core (felsic peraluminous compositions, low HFSE and REE, high LILE contents and LREE/HREE ratios, and negligible negative to positive Eu anomaly) that infer to a common mechanism of granite magma generation, e.g. crustal melting. The younger age of the anatectic melts (37-38 Ma) precludes direct feedback relations between intrusive granites and migmatites. A low temperature crustal melting involving mainly felsic minerals from orthometamorphic substratum could explain the granite magma origin and its similarities with the younger anatectic melts from the CRMCC core.

Acknowledgements: This work was supported by the National Science Fund of the Ministry of Education and Science in Bulgaria, projects DO 02-363/2008 and DO 02/-327/2008.

The exhalations of CO₂ in the Poprad River valley (Polish Inner Carpathians)

Rajchel J.¹ and Rajchel L.²

¹*Department of General Geology, Environment Protection and Geotourism, Faculty of Geology, Geophysics and Environment Protection, AGH - University of Science and Technology, 30 Mickiewicza Av., 30-059 Kraków, Poland, jrajchel@geol.agh.edu.pl*

²*Department of Economic and Mining Geology, Faculty of Geology, Geophysics and Environment Protection, AGH - University of Science and Technology, 30 Mickiewicza Av., 30-059 Kraków, Poland, rajchel@geol.agh.edu.pl*

The Krynica tectonic-facies zone within the Magura Unit of the Polish Inner Carpathians contains a region rich in carbonated mineral waters and in moffettes, i.e., dry exhalations of carbon dioxide. The lithostratigraphic profile spans the strata from the Upper Cretaceous to Upper Eocene. The region of the moffettes studied is situated in the Poprad River valley between Muszyna and Tylicz. The exhalations have been found in the Złocki stream and Jastrzębik stream valleys near Muszyna, in the Szczawiczny stream valley near Krynica and in Tylicz. The largest and most beautiful exhalation with an area of about 25 m² occurs in the bottom of the Złocki stream valley. Both this exhalation and the smaller, adjacent exhalations and the springs of carbonated waters are associated with the Szczawnik-Złocki-Jastrzębik antiformal structure and with a system of discontinuous dislocations, i.e., a thrust and faults. The emanating gas represents almost pure CO₂ (about 99.3%) with minor admixtures of CH₄, N₂, Ar and other noble gases.

The upper surface of the basement of the Carpathian orogen in the Poprad subregion rests at a depth of about fifteen kilometers. The origin of the gaseous components – particularly of CO₂ – is usually attributed to metamorphism of carbonates rocks under the thick cover of overthrust flysch strata and/or to Tertiary volcanism. The volume of carbon dioxide emanating from the moffette in question is about 15,000 m³ CO₂/day. The maximum content of CO₂ in the soil air close to the moffette reaches 94%. The temperature of the emanating gases is around +10°C, both in the Złockie site and in other moffettes of the region.

The moffette is partly covered by the water of the stream and also by the water flowing out of submerged springs of carbonated mineral waters, thus the emanations are manifested by smaller or larger bubbles of carbon dioxide. They are accompanied by rusty-coloured, gelatinous floccules of colloidal hydrohematite and goethite, the minerals originating by oxidation and hydrolysis of hydrated ferrous carbonate contained in the mineral waters mentioned. The process is a result of metabolism of the green plants populating this habitat (forest bulrush *Scirpus silvaticus* is a dominating species), and also of ferruginous bacteria

Ferribacterium sp., cyanide plants (Cyanophyceae), euglenines (Euglenophyceae), diatomeae (Bacillariophyceae) and green algae (Chlorophyceae).

In the year 1998 the moffette in Złockie was declared a legally protected site as the Professor Henryk Świdziński monument of inanimate nature and later placed on a proposed European list of protected geosites (European List of Geosites).

Acknowledgements: Research has been supported by AGH – University of Science and Technology in Cracow, grants no. 11.11.140.447 and no. 11.11.140.598.

Mineral, thermal and therapeutic waters of the Polish Carpathians

Rajchel L.¹ and Rajchel J.²

¹*Department of Economic and Mining Geology, Faculty of Geology, Geophysics and Environment Protection, AGH-University of Science and Technology, 30 Mickiewicza Av., 30-059 Kraków, Poland, rajchel@geol.agh.edu.pl*

²*Department of General Geology, Environment Protection and Geotourism, Faculty of Geology, Geophysics and Environment Protection, AGH - University of Science and Technology, 30 Mickiewicza Av., 30-059 Kraków, Poland, jrajchel@geol.agh.edu.pl*

The province of the Polish Carpathians is characterized by a wealth of various mineral, thermal and potentially therapeutic waters, and by a coexistence of normal, mineral and thermal waters as well.

The Inner Carpathians enclose the Podhale Basin and the Tatra Mountains, the latter being the major recharging area of underground waters. The Podhale Basin represents a classic artesian basin, in which the carbonate strata of Eocene and Triassic carry thermal waters recorded at the depths from 680 m (Zazadnia IG-1) to 5261 m (Bańska IG-1) in 14 boreholes. The temperature of the waters ranges from 20 to 86°C at the mineralization (TDS) from about 0.3 to 3 g/dm³. They are utilized in recreation and in heating installations.

The waters in question within the area of the Pieniny Clippen Belt are limited to a few springs of sulphurous water.

The Outer, i.e., Flysch Carpathians, are composed of tectonic units of a lower rank overthrust on each other, strongly dislocated and dismembered into separate blocks. Within their area the following water types have been found: carbonated waters, waters containing carbon dioxide, chloride waters, brines, thermal waters and sulphurous waters. The carbonated waters and waters containing carbon dioxide have currently been rendered accessible in 68 springs and 138 boreholes, and occur only within the areas of the Magura and Silesia units. They represent waters with mineralization (TDS) from 0.4 (acratopegae) to 27 g/dm³, and their hydrochemical types are HCO₃-(Ca)-(Mg)-(Na), (Fe), (I), and HCO₃-Cl-Na, (Fe), (I). In Krynica, waters of the Zuber type, unique in the world, are provided from four boreholes on the slopes of Parkowa Góra Mt. The Zubers are carbonated waters with the TDS content from 21.2 to 29 g/dm³ of the hydrochemical type HCO₃-Na-(Mg), I. The chloride waters and brines occur within all the tectonic units of the Outer Carpathians and their TDS content ranges from 35 to about 146 g/dm³ (the latter in Jaworze Dolne). They have been reported in many boreholes drilled mainly during oil and gas prospecting. The chloride waters (e.g. in Rabka and Poręba Wielka) and brines (Sól, Jaworze, Krosno) are mostly synsedimentary waters of the Cl-Na, I type. They are associated with both the Carpathian flysch strata and the older rocks (Devonian, Carboniferous) of the Carpathian basement (Ustroń Śląski, Kęty, Jaworze). For instance, the uptakes in Ustroń pump thermal brines of the Cl-Na-Ca type, the TDS content 103-126 g/dm³ and the temperature 50°C from the Devonian basement. The sulphurous waters have been recorded in 125 springs within the Carpathians. They contain H₂S in the range 1-160 mg/dm³ at the TDS ranging from 0.3 to 3.6 g/dm³; most of these waters are acratopegae.

Natural radioactivity of uranium (²³⁸U, ²³⁴U), radium (²²⁸Ra, ²²⁶Ra), radon (²²²Rn) and lead (²¹⁰Pb) isotopes as well as the total concentration of the α- and β-radioactive nuclides have been studied in 75 water samples from the area of the Polish Carpathians. The results indicate that in none of them the content of radioactive elements exceeds the values permitted by radiological regulations.