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Extended Abstracts

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title: **Chemical composition of spring water in the northern boundary zone of the Tatra Mountains (East-Central Europe)**

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Springs located in the northern boundary zone of the Tatra Mts. were investigated in the past according to their potentiality in water management (Małecka 1993, 1997; Małecka, Roniewicz 1997; Małecka, Małecki 2005). Water intakes are located at some of them. Springs have drained carbonate Eocene rocks, which neighboring from north the Podhale flysch rocks (Figure 1). Differences between hydrogeological properties of carbonate Eocene rocks and Podhale flysch rocks are conducive for occurrence of springs in this zone. The aim of researches is to investigate physical and chemical characteristics of springs with varied discharge.

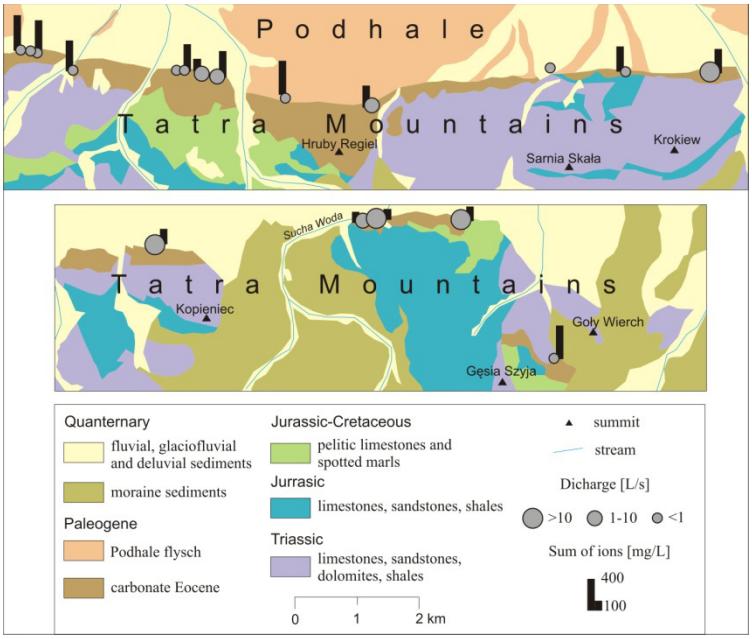

Figure 1. Discharge and mean sum of ions in investigated springs at the background of geology (after Geologicka Mapa Tatier, 1986).

Carbonate Eocene rocks have an important role in hydrogeology of the north part of the Tatra and the Podhale. Precipitation witch infiltrate in carbonate Eocene outcrops in Tatra recharge groundwater aquifer lying under flysh in Podhale artesian basin (Małecka, Małecki, 2005). A karst phenomena is developed in some parts of the carbonate Eocene, especially in the Sucha Woda basin, in the east part of the Tatra (Głazek, Wójcik, 1963). Springs witch have drained carbonate eocene are recharged by rainwater which is infiltrated and inflowed within all Tatras (Małecka, Małecki, 2005).

18 springs were investigated. Field works were conducted in April, June and October 2007. Water temperature, electrical conductivity and pH were measured in terrain (Elmetron CX-401) and water samples (from 15 springs) were taken in June and October. Chemical analyses were done in the laboratory at the Institute of Geography and Spatial Management, Jagiellonian Univeristy using ion chromatography (DIONEX ICS-2000). Mineralization was counted as sum of all measured ions. Based on measurments from three or two months mean values of physical and chemical characteristis were calculeated.

Among investigated, nine are debris springs and the rest are rocky ones. There are vaucluse springs: Koziarczyska (mean discharge 87.1 L/s) and Przyporniak (mean discharge 60.0 L/s) (Małecka, Roniewicz, 1997). Discharge of rest of springs varied from 0.01 L/s to 20 L/s (Figure 1). Discharge of debris springs were a little bit higher in June when there was rainfall before and during field works. In June also one periodic spring was noticed in the west part of area (Figure 1). Water temperature of most springs amounted between 5.0–7.5 °C and was stable during all investigations period. Temperature higher than 7.5°C was noticed only after a fresh rainfall.

Mean sum of ions varied from 126 to 418 mg/L. Values lower than 200 mg/L was noticed in vaucluse springs and in two karst-fissure springs, which also have drained karst rocks in the west part of area. The highest values of sum of ions were noticed in two debris springs located at most west and east part of investigated area (Figure 1). Mean electrical conductivity were from 151 to 452 μS/cm. The highest and lowest values occurred in the same sites that maximum and minimum of sum of ions. Electrical conductivity and sum of ions are statistically correlated. Reaction was typical for carbonate rocks and not very divers. Mean values were form pH=7.29 to pH=8.45.

The type of springs water was HCO_3-Ca-Mg or HCO_3-Ca. Among kations the highest concentration had Ca^{2+} (Table 1). Sum of Ca^{2+} and Mg^{2+} in each spring made more than 90% of all kations in mval/L. Another kations are Na^+ with had concentration approximately 1 mg/L and K^+ and NH_4^+, with concentration lower than 1 mg/L. Among anions considerable higher concentration had HCO_3^-, and it dominated also in structure of chemical composition. It constituted 86.1-98.4% of sum of all anions in mval/L (Table 1). Next anion with the highest concentration was SO_4^{2-}, but it constituted only about 5% of anions. Other anions were Cl^- (concentration 0.1-0.9 mg/L) and NO_3^- (concentration 0.2-2.0 mg/L).

The lowest values and participation of HCO_3^- occurred in vaucluse springs and in karst-fissure spring in Sucha Woda basin. The highest concentration of SO_4^{2-} were also observed in them.

Table 1. Mean values of concentration [mg/L] and percent of sum of kations or anions [%] in spring water (n=15).

		Main kations		**Main anions**	
		Ca^{2+}	**Mg^{2+}**	**HCO_3^-**	**SO_4^{2-}**
Concentration [mg/L]	minimum	25.03	3.47	84.18	2.75
	maximum	84.78	21.41	316.95	13.85
	mean	52.35	12.09	214.34	7.80
Percent of sum of kations or anions [%]	minimum	60.7	12.8	86.1	1.1
	maximum	85.4	38.3	98.4	11.1
	mean	71.4	26.4	93.0	5.2

Physical and chemical characteristics were stable during researches. That confirm deep recharge aquifer. Chemical composition of waters indicates draining carbonate rocks. Similar structure of chemical composition of debris and rocky springs concessived that debris springs also are draining the carbonate Eocene rocks. It may be stated, that these types of water are representative for water circulating in carbonate eocen rocks.

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