GERMANIUM GEOCHEMISTRY IN MINERAL GROUNDWATER FROM MOUNTAIN AREAS OF SOUTHERN POLAND - A CASE STUDY OF ITS AFFINITY TO OTHER ELEMENTS

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Germanium commonly demonstrates silicon-like geochemistry, and is used as a tracer of petrogenetic processes leading to (re)crystallization of rocks in mantle, metamorphic, magmatic environments. Ge-geochemistry is also very promising in tracing low temperature events. In continental crust, mean Ge content is 1.4 ppm and mean Ge:Si molal ratio of 1.7E-6. In groundwater, the highest Ge content is usually found in geothermal aquifers, which occur in reactive silicates-rich bedrocks. Germanium evokes the rousing interest also in biology and medicine. In some countries, Ge-rich mineral waters are applied in balneotherapy, or are accessible as a bottled waters. The Ge-Si relationship becomes particularly interesting to study in Ge- or Si-rich groundwater. Geochemical study revealed increased Ge content in mineral waters of the Sudetes and the Bieszczady mountains, Southern Poland. In the Sudetes (SM) two main types of medicinal waters used in balneotherapy occur: lowenthalpy CO_2-rich waters, and thermal SO_4-HCO_3 waters with F, H_2S and Rn. Both types are enriched in Ge with respect to crust composition. The Ge and Si concentrations are of 0.03 – 10.25 ppb (mean 1.88 ppb), and of 4.34 – 43.66 ppm (mean 21.35 ppm), respectively. The Ge content in SM correlates with Si, depends mainly on water temperature and reactivity of silicates, and show Ge:Si ratio from 1.2E-6 to 218E-6 (mean 34E-6). In the Bieszczady (range of the Carpathians), mineral waters (BM) are currently studied at site where low-enthalpy CO_2-rich HCO_3-Cl-Na (with increased H_2S, B) waters are planned to use for balneotherapy. The BM show Ge content higher than in SM, and a different Ge-Si pattern. The Ge and Si content in BM are of 0.08 – 35.8 ppb (mean 7.4 ppb), and of 1.75 – 8.82 ppm (mean 4.6 ppm), respectively. The maximum Ge content in the BM is the highest one which have been found hitherto in groundwater of Poland, and is at the same level as Ge content in thermal waters of the world. The Ge:Si ratio in BM varies from 11.4E-6 to 2692E-6 (mean 611E-6). In sedimentary rocks of BM area, accessory sulphide minerals (pyrite, marcasite, sphalerite, galena, realgar, orpiment) occur. In BM, Ge does not show correlation with Si, Zn, or Fe, but it correlates positively with As, what suggests that orpiment is the dominant Ge-source mineral phase in this environment. Study of BM indicate that Ge-rich water might be also found in low-enthalpy environments in bedrock, which is enriched in sulphides.

Keywords: germanium, silicon, mineral water