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## **EXPERIMENTAL INVESTIGATION OF BERYLLIUM MOBILITY: A CASE STUDY FROM KARKONOSZE GRANITOID MASSIF**

### INTRODUCTION

The rocks of Karkonosze massif are considered slightly enriched in beryllium. Beryllium forms own minerals as well as is spread as trace element in rock forming minerals. Beryllium bearing minerals, gadolinite-Y  $Y_2FeBe_2Si_2O_{10}$  and beryl  $Be_3Al_2Si_6O_{18}$  have been found in Karkonosze pegmatites (Gajda, 1960; Sachanbinski, 1970; Włodyka et al., 1983). For different facies of Karkonosze granite the average Be content ranges from 3,4 to 6,6 (Lis, 1970). Similar values have been obtained for 6 selected granite and 10 pegmatite samples from Szklarska Poręba vicinity (Potok Kobyła, Szklarska Poręba Huta, Czerwona Jama), Krucze Skąły and Karpniki outcrops: fresh granite 0.3-8.61 (with the average 4,09 ppm), pegmatite 0.00-10.5 (with the average 3,11 ppm). Beryllium concentration in all of the samples has been estimated by ICP-MS method. Be minerals have not been found in the examined samples. Although beryllium is thought to be less mobile element due to the high resistance of its minerals, dispersed in silicates could be mobilised during alteration processes (Barg et al, 1997). The aim of the present experiment was to determine the Be mobility under weathering, and low-temperature hydrothermal processes. Therefore the following data have been collected: the trace element composition of fresh, hydrothermally altered, and weathered rock; the trace element composition of the soils covering each outcrop. Additionally hydrothermal leaching has been performed.

### EXPERIMENTAL HYDROTHERMAL LEACHING

The mobility of Be under hydrothermal conditions has been measured using cation exchange resin (low temperature hydrothermal alteration). Powdered samples have been mixed with cation exchange resin ( $H^+$  form, Dowex 50WX8-200) in bi-distilled water. The mixture was stirred and held at temperature of 70°C in an autoclave. The leaching time has been chosen arbitrary: 2, 4, 8 and 48 hours. After experiment the resin was eluted in 4N  $HNO_3$ . The composition of the

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obtained post-run solution was investigated by means of ICP-MS analysis. It is noticeable, that the beryllium leaching process affected by hot water gives measurable results even in a short time. Be concentration in extracted (from five pegmatite and granite samples) solutions varied from 0,08 to 0,50 mg/kg. Solutions gained from weathered granite samples (Szkłarska Poręba Huta) were much more enriched in beryllium comparing with other ones. There is no visible connection between beryllium concentration in the solutions and the run duration. In several cases, the largest amounts of Be were leached in the first two hours of experiment, what could be related to better release of the element from the minerals surface.

### SEQUENTIAL EXTRACTION OF THE SOILS

Five steps of sequential extraction have been applied in order to determine the beryllium mobility in the soils. Soils samples have been collected from vertical profiles above the mentioned outcrops. They present mostly “ranker” brown, acid brown and podzols. Three horizons could be distinguished in each soil profile: iron – humus, illuvial and weathered bedrock. The samples was grounded and sieved into two fractions: <1mm and >1mm. Sequential extraction of the <1mm fraction from each sample has been carried out according to the following, stepwise procedure (Kersten and Förstner, 1987): step 1 – ammonium acetate extraction (the step is a fair indication of cation exchange capacity; in natural environment it could correspond to activity of meteoric water percolating the soil profile); step 2 – dilute acetic acid extraction (an indication of acid-soluble minerals content; it could correspond to an acid rain activity); step 3 – hydroxylamine / acetic acid extraction (an indication of dissolution of Fe- and Mn- oxyhydroxide; it could correspond to low-redox conditions in natural system); step 4 – hydrogen peroxide extraction (organic / sulphidic fraction); step 5 - hot concentrated nitric acid extraction. After last extraction, in the residuum only acid resistant minerals remain. The total beryllium content has been determined in every soil horizon in order to quantify the amount of mobilised Be species in respect to Be concentration in the rock. In the present paper the soil profile from Szkłarska Poręba Huta is presented (Fig. 1). The obtained results for other profiles are similar to the presented one. The total Be content for each horizon (from the iron – humus to bedrock) has been estimated respectively as 2,40-, 0,31- and 1,20- ppm, whereas the rock samples contained 4,94 - 9,01 ppm of the element. The lowest value was obtained for weathered granite. The noticeable impoverishment in Be suggests significant mobilization of beryllium at the beginning of alteration processes. However beryllium concentrates in each horizon in different fractions, some rules are noticeable. The ion exchange fraction is beryllium free. Beryllium concentration increases in next fractions: carbonate, reducible, sulphidic and especially in residual one. The amount of reducible fraction in the bedrock is negligible.

The data obtained from sequential extraction show, that beryllium could be removed during each step of the extraction (Fig.1). During sequential extraction 17% of the total Be content from iron – humus level has been removed. The whole

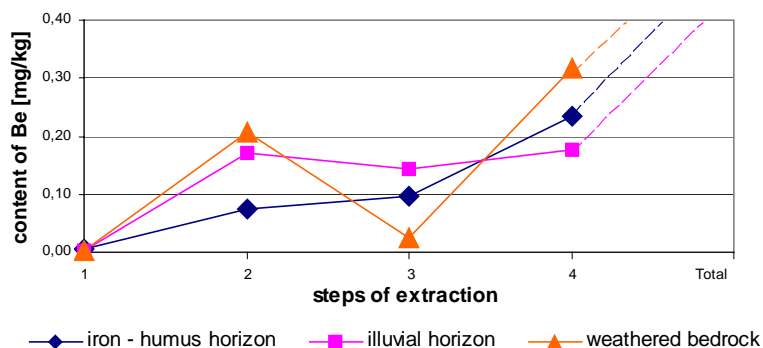


Fig. 1 Release of Be during the sequential extraction (Szkłarska Poręba Huta profile).

Be concentrates in cation – exchange till organic / sulphidic fraction in the illuvial level. Almost half of the whole Be amount (46 %) was extracted during sequential analysis from weathered bedrocks.

## CONCLUSIONS

Although Be is considered as less mobile element, the performed experiments show, that its significant mobilisation is possible during both hydrothermal and weathering processes.

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