MICRO-PIXE INVESTIGATION OF THE TRACE ELEMENTS IN THE MINERALS OF THE RÓZSABÁNYA HYDROTHERMAL ORE DEPOSIT (BÖRZSÖNY MTS., NORTH HUNGARY)

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Introduction

The hydrothermal ore deposit of Rózsabánya near Nagybörzsöny village is located at the central part of the Börzsöny Mountains in Northern Hungary. The surrounding volcanic area is made up Miocene calc-alkaline intermediate rocks, predominantly andesites with minor amounts of dacites. The ore mineralization occurs as stockwork impregnation in propylitic dacite breccia pipe (PANTÓ & MIKÓ, 1964; NAGY, 1983). The age of the hydrothermal activity is 15.2–14.8 Ma (KORPÁS & LANG, 1993). The ore formation took place in two major phases. The ores of the first phase include mainly pyrrhotite with Fe-rich sphalerite and chalcopyrite. The minerals of the second phase were formed partly by the replacement of the earlier precipitated ores. The ore paragenesis of the second phase is characterized by arsenopyrite, galena, Bi-minerals, Pb-Bi sulphosalts (lillianite-gustavite) and native gold.

Though detailed electron microprobe study has been carried out on the ore minerals of Rózsabánya, trace elements cannot be determined using electron beam methods. We aimed to analyze the trace element contents of the most important ore minerals using the much more sensitive proton-induced X-ray emission (PIXE) technique.

Samples and methods

Samples used in present study were collected from the Rózsa shaft by G. Pantó and L. Mikó during the exploration of the Börzsöny Mts. in the fifties of the last century.

Micro-Particle Induced X-ray Emission (micro-PIXE) analysis was performed using the scanning nuclear microprobe at the Institute for Nuclear Research, Debrecen, Hungary (KERTÉSZ et al., 2015). The nuclear microprobe is installed at the 0° beamline of the 5MV Van de Graaff accelerator. The minerals were irradiated with a focused H^+ beam with 2.5 MeV energy and of 200–300 pA. The beam size was 1.5 μm × 1.5 μm.

Results

Trace element contents of pyrrhotite, sphalerite, chalcopyrite, arsenopyrite, pyrite and galena were determined. Of the minerals, the iron-rich sphalerite contains the widest range of trace elements. The Cd and Mn contents of the sphalerite have already been known from the earlier electron microprobe measurements, but the relatively high concentrations of Co (790 ppm), Cu (950 ppm), and high Ga (2540 ppm) and In (1130 ppm) contents haven't been detected earlier, though traces of In have previously been found by optical emission spectrography in the ores of Rózsabánya. In chalcopyrite, significant amounts of Sn (1010 ppm), In (650 ppm) and Co (1950 ppm) could be analyzed. The only trace element of pyrrhotite is Co (4670 ppm), Cu and Ni could not be detected. Pyrrhotite is one of the oldest and most abundant minerals in the Rózsabánya ore, and later minerals as pyrite, arsenopyrite were partly formed by the alteration and re-arrangement of the high temperature primordial pyrrhotitic material. Therefore, the high concentration of Co in pyrite (3870 ppm) is the result of pyrrhotite alteration and replacement, where the newly formed pyrite "inherited" the Co content of the original pyrrhotite. Arsenopyrite contains more than 1 wt% Co, which is in good agreement with the existing electron microprobe data. The source of the Co in arsenopyrite can either be the altered pyrrhotite, or the hydrothermal solutions of the second mineralization phase. The importance of cobalt in Rózsabánya is shown by the fact that it was detected in almost all major ore minerals. The other significant trace element in arsenopyrite is Se (2430 ppm). Galena crystallized during the late stages of the ore formation. Its trace elements are Ag (950 ppm) and Se (1930 ppm).

These are our first trace element results for the sulphides of the Rózsabánya mineralization. According to our experience, micro-PIXE is a suitable non-destructive method for quantitative analysis of trace elements in ore minerals.

References

KERTÉSZ, ZS., FURU, E., ANGYAL, A., FREILER, Á., TÖRÖK, K. & HORVÁTH, Á. (2015): Journal of Radioanalytical and Nuclear Chemistry, 306: 283–288.

KORPÁS, L. & LANG, B. (1993): Ore Geology Reviews, 8: 477–501.

NAGY, B. (1983): Acta Geologica Hungarica, 26: 149–165.

PANTÓ, G. & MIKÓ, L. (1964): Annals of the Hungarian Geological Institute, 50/1: 1–153.