INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS OF MONOMINERAL FRACTIONS OF SULFIDE MINERALS AND QUARTZES

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A method has been worked out of multi-elemental instrumental neutron-activation analysis INAA of small weights some mg of monomineral fractions of sulfide minerals pyrites, galenites, chalcopyrites, arsenopyrites, bornites, chalcosines and quartzes. The samples were irradiated in a nuclear reactor under a flux of \(1.3 \times 10^{13} \text{ n cm}^{-2} \text{s}^{-1}\). For measuring the gamma radiation of the exposed samples Ge(Li) gamma-spectrometers with semiconductor detectors were used. Determined in sulfide monofractions were the elements: Co, Sc, Ag, Se, Sb, Cr, Fe, Zr; rare-earth elements: Ce, Sm, Eu and others at content levels of \(10^{-1} - 10^{-4}\%\). In quartzes they were: Mn, Na, Sb, Cr, Sc, Fe, Co at content levels of \(10^{-5} - 10^{-7}\%\) and Au to \(10^{-9}\%\). A special method has been worked out for the determination of In in sulfides with the irradiation of samples in a cadmium screen. An example is cited of using the method for studying some peculiar features of the genetics of copper pyrite deposits. The data on the distribution of admixture elements in sulfide monofractions produce in this work made it possible to conclude that the ore-formation in the deposits has a stage-by-stage character.

Introduction

The elemental composition of minerals is an important characteristics of geochemical processes. This is particularly true of micro-admixtures which often occur as indicator elements of ore-formation processes.

Even the smallest weights of monomineral fractions, from the point of view of their elemental composition, are representative for characterizing the conditions of the formation of mineral associations.

On the other hand, elemental analysis of monofractions is difficult mainly for two reasons: (1) many methods of analysis require relatively large weights, in ex-
cess of 0.1 g, whereas the drawing of very small granules of minerals under the microscope is a labour-consuming and costly operation, moreover, it is not always possible to draw such weights; (2) some analytical methods (spectral, atomic-adsorption, etc.) result in the destruction of the drawn unique sample which precludes the repeated checking of the analyses. Therefore, for the analysis of monomineral fractions of small weights the instrumental neutron-activation analysis (INAA) is very promising, since it allows to detect and determine with a high degree of accuracy the presence of many trace elements.

Thus, for example it was shown earlier that, according to INAA data on sulphide monomineral fractions drawn in the area of tin-ore deposits, it was possible to determine Se, Ag, Co, Sb, Cr, Zn, In, Sc, Ce at contents of \(10^{-1} - 10^{-5}\)% The obtained results permitted some conclusions about characteristic ratios of concentrations of the indicator-elements inherent in certain types of deposit formations.

This work gives the results of a developed INAA method for sulphide monomineral fractions pyrites, pyrrhotites, chalcopyrites, arsenopyrites, galenites, bornites, chalcosines and quartzes for geochemical research purposes.

Analysis methods

Sulphide monofractions

The content of admixture-elements in monofractions may vary by several orders, depending on the type of deposit and place of sampling. As a rule, no preliminary data or rather inaccurate data are available on the elementary composition of the samples under examination. These circumstances create certain methodological difficulties in conducting multi-elemental INAA with respect to the optimization of the mode of analysis, selection of standards for comparison, etc. When developing this method, the possibility of its industrial application was also taken into account. In this case the productivity of the method has a definite importance, too.

For carrying out analysis the selected samples pyrites, chalcopyrites, galenites, etc. in weights up to 20 mg were packed in aluminium foil and exposed to radiation together with the standards in a nuclear heavy-water reactor in a flux of \(1.3 \cdot 10^{13} \text{ n cm}^{-2} \cdot \text{s}^{-1}\). Calculations and standard measurements showed that with the exposure time of 20 hours one can confidently determine a great number of elements at a sensitivity not lower than \(10^{-4}\)% Irradiated at the same time were 20 to 40 samples of monofractions which ensured the required productivity of the analysis. For raising the precision of information about the elementary composition of monomineral sulphide fractions and for evaluating the analytical error, parallel samples were drawn in every case whenever the total weight of the sample made this possible.