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GAMMA-SPECTROMETRY OF THE SAMPLES FROM MUZHIYEVO MINE

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The experimental results obtained during the development of activation analysis of the samples of ores in Muzhiyevo are considered. Using the M-30 microtron (IEP UNAS) (E_e = 18,5 MeV electron energy; I_e = 5 μA average electron current; 2 hours irradiation exposure; 100 cm^3-DGDK detector; NTA 512B analyzer).
The qualitative and quantitative estimation of element composition of samples (As, Ag, Au, Br, Mn, Fe, Cn, etc.) was performed. The estimation of the expedient time modes for serial analysis was made. Based on the analysis of systematic and random errors, the estimation of the possible rank of activation analysis in the industrial ore production and preprocessing technologies.

Gold determination in ore samples

The determination of gold content in ores belongs to the most complicated tasks. The up-to-date requirements to the ore analysis are as follows:

1. The Au determination limit is not worse than 5×10^{-5} % ;
2. The analysis capacity is about 1 analysis per minute;
3. The analysis error at gold concentration of 2 g/t is about 10% (relative);
4. The mass of the sample under testing is about 0.5 kg;
5. Automated data processing.

Activation analysis of the samples at the M-30 microtron

According to the goal of investigation — the development of non-destructive method of determination of the element composition of geological samples — the following problems have been outlined.

1. Experimental data processing.

1.1. Qualitative analysis of the element composition of standards and samples:

— total adsorption peak (TAP) identification;

— line identification;

— gamma-active nuclide (GAN) identification;

— target nuclide and chemical element identification;

— selection of possible analytical schemes for Au and Ag extraction.

1.2. Quantitative analysis: TAP quantitative characteristic calculation:

— time parameter (TP) function calculation;

— estimation of the relative Au and Ag content;

— error calculation (mean and statistical).

2. Analysis of the obtained quantitative characteristics:

— relative content dependencies on the cooling duration;

— optimal analysis conditions;

— systematic and statistical error of Au and Ag determination in the SiO_2 standards and the matrix-less standards;

— element composition of samples.

3. Estimation of the Au and Ag activation analysis possibilities in geological samples: determination limits.

Quantitative analysis

The quantitative analysis, i.e. the production of certain numerical characteristics, is a continuation of the qualitative analysis and may effect substantially its results. The following values — ΔS (TAP-area), Φ (background), S (summary area), TP, C (relative specific contents), ε_1, ε_2 ((mean errors), α (statistical errors) — were calculated using the relations [1]. The calculation of ΔS, Φ, S, which characterize TAP has been performed for all TAPs, the TP calculation has been carried out for the following GANs: Au^{198}, Au^{196}, Ag^{106m}, Ag^{110m} for all the experimental spectra. The calculation of the relative specific contents C, average values $\overline{C}$ and error has been performed for lines being chosen as the analytical ones. These lines are 355.7 keV for Au^{196}, 411.8 keV for Au^{198}, 657.7 and 884.7 keV for Ag^{110m}, 451 keV and 1046 keV for Ag^{106m}.

Analysis of the quantitative characteristics

Some results (which have to be considered as the estimate of the present study as the method development stage) are presented in Figs. 1—2.

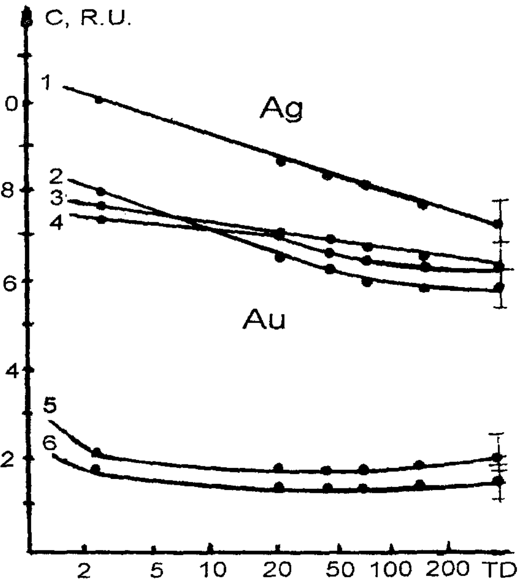

Fig 1. The dependences of the relative specific contents C (in relative units) for Ag (1 – 657,7keV Ag^{110m}; 2 – 884,7keV Ag^{110m}; 3 – 451,0 keV Ag^{106m}; 4 – 1046 keV Ag^{106m}) and for Au (5 – 411,8 keV Au^{198}; 6 – 355,7 keV Au^{196}) on the cooling time TD (hours) – sample A.

Figures 1—2 show the dependences of the relative specific contents for Au: 355.7 keV for Au^{196}, 411.8 keV for Au^{198}; for Ag: 657.7 and 884.7 keV for Ag^{110m}, 451 keV and 1046 keV for Ag^{106m}, on the cooling time (TD).

A preliminary analysis of the results of the experimental data processing allows the following conclusions to be formulated.

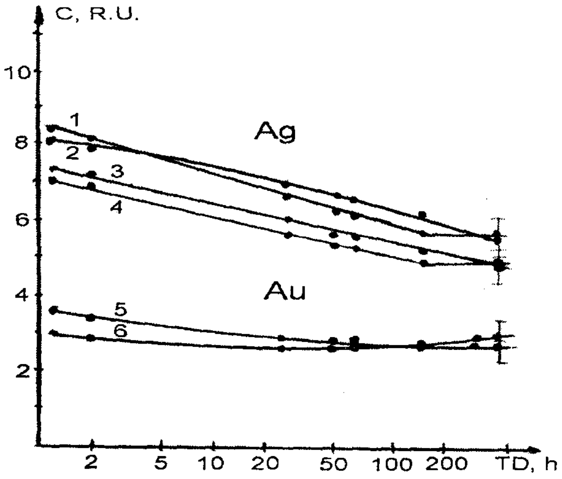

Fig 2. The dependences of the relative specific contents C (in relative units) for Ag (1 – 657,7keV Ag110m; 2 – 884,7keV Ag^{110m}; 3 – 451,0 keV Ag^{106m}; 4 – 1046 keV Ag^{106m}) and for Au (5 – 411,8 keV Au^{198}; 6 – 355,7 keV Au^{196}) on the cooling time TD (hours) – sample B.

1. The availability of the systematic error (especially in Ag determination) due to the presence of measurable As amounts in the samples. The contribution of these errors into the total error decreases with cooling time. Beginning from $T_D \approx 50$ hours the systematic error decreases. In Au determination the cooling time interval is not so limited, however the difference in the behavior of dependencies for 411.8 keV line for Au^{198} and 355.7 line for Au^{196} depending to different analytical schemes is clear, while, besides the complexity of analytical schemes, one should note their applicability.

2. The experimental points scatter indicates the error, which may characterized as random as well as to the violation of the conditions for which the relations for calculation of ΔS, Φ, S, TP hold true. This fact being one of the shortcomings of the randomized experiment should be taken into

account at the further stages of the development of that method, first of all, by preparing the relevant standards on the basis of the similar sample matrix, its homogenization, etc.

References

1. M.Stets, M.Hoshovsky, O.Parlag, V.Buzash, V.Okogrib, *Uzh. Univ. Scient. Herald, Ser. Phys.* **8**, 336 (2000).

ГАММА-СПЕКТРОМЕТРІЯ ЗРАЗКІВ МУЖІЇВСЬКОГО РОДОВИЩА

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Розглядаються результати експериментальних даних, отриманих у процесі розробки активаційного аналізу зразків руд Мужіївського родовища на мікротроні М-30 ІЕФ НАН України (енергія прискорених електронів 18,5 МеВ, середній струм прискорених електронів 5 мкА, тривалість опромінення 2 год; 100-см^3 ДГДК-детектор; аналізатор NTA-512B). Зроблено оцінку відносного вмісту золота та срібла та доцільних часових режимів серійних аналізів. На основі аналізу джерел систематичних похибок робиться висновок про можливості та доцільність гамма-спектрометрії зразків такого типу.