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Investigation of the possibility of controlling the uranium concentration in natural and man-made raw materials of various compositions by INAA based on Cf-252 radionuclide neutron source

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Determination of uranium by the INAA method was carried out with by a neutron activation unit. The unit was developed in the Institute of Chemistry of the Far Eastern Branch of the Russian Academy of Sciences, Vladivostok city. A 252Cf radioisotope source (type NK252M11) with a total neutron flux of 109 s-1 was used as a neutron source. Plexiglass was used as a moderator. It has been providing the maximum flux of thermal neutrons in the activation zone. To determine uranium by the INAA method, the capture reaction 238U + n → 239U + γ was used. The activation time of the samples varied from 30 to 90 minutes. The measurement time was 30 minutes. The quantitative determination of uranium was carried out using the photopic isotope 239U with an energy of 74.6 keV.

Calibration graphs of the dependence of the analytical signal intensity on the concentration of uranium concentration in the range from 15 to 300 ppm by the method of additives for samples of aluminosilicate sand were obtained. The maximum nonlinearity of the graphs does not exceed 6 and 5% for samples with a volume of 50 and 100 ml, respectively. It was established that the limit of detection and the limit of quantitative determination is 12.7±1. and 38.1±4.5 ppm for samples volume is 50 ml and 7.96±0.45 and 23.9±1.4 ppm for samples volume is 100 ml.

Similar measurements were carried out for samples of different mineral composition. A significant effect of the elemental macro composition of samples on the results of uranium determination was shown. It due to the absorption of thermal neutrons by the matrix components of samples during activation and the absorption of gamma ray of the 239U in the sample volume. The presence of trace elements with a high thermal neutron capture cross-section has been shown to have a significant effect on the results of neutron activation determination of uranium. When impurities (Y, Eu, B) introduced into samples –the analytical signal of 239U was decreased. The contribution of each of the factors for different samples types was calculated. Taking into account the macrocomposition of samples and the content of microimpurities that absorb neutrons allows to effective determination of uranium by the INAA method using a radionuclide neutron source based on Cf-252.

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