X-ray fluorescence analysis of major and trace-elements in Ukrainian uranium ores

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The determination of the uranium concentration in ores, as well as the concentrations of other major and trace-elements, is particularly important for Ukraine – one of the top ten world producers of uranium ore. X-ray fluorescence spectrometers are cost-effective, and widely used to perform direct, rapid and non-destructive measurements of the content of major and trace elements in various materials. While modern XRF instruments are equipped with systems that allow one to take into account effects of inter-element interferences, there remains a need to optimize XRF analysis techniques for measurements of geologic materials with ore-grade uranium concentrations.

We report results from analysis of the elemental composition of Ukrainian uranium silicate ores using a Bruker S8 TIGER WDXRF spectrometer. Two types of samples were investigated: four State standard samples of uranium ore with known uranium concentrations from 0.047 to 0.768 % by weight, and four samples of uranium ore taken from Kirovograd ore deposit (Ukraine). We determined the major element oxide (SiO_2, Al_2O_3, Na_2O, CaO, Fe_2O_3, MgO) and trace element oxides (K_2O, MnO, P_2O_5, SO_3, TiO_2, U_3O_8) concentrations in these materials.

Initial concentrations in the standard uranium ore samples were determined using the code Eval2 and spectral results of sample measurements interpreted by QUANT-EXPRESS (Bruker). Using the standard samples and Spectra^{plus} software, we established calibration curves to correct for the concentration dependence of major and trace element oxide intensities. For the major element oxides with concentrations greater than 15% by weight, the maximum relative error of measurement (calculated as 1σ) does not exceed 2%. For the trace element oxides, the maximum relative error was 20%. The concentration of uranium was determined with an maximum relative error 10%. Differences between the measurement results for loose powder samples and samples in the form of pressed pellets were also evaluated. Using optical microscopy was shown that in all samples, the size of the bulk of particles was 80 to 140 μm. We will discuss the validity of our results, and propose ways to reduce measurement errors.