# Determination of uranium content in silicate uranium ores by gamma spectrometry combined with ISOCS

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The ISOCS mathematical method developed by Canberra Industries is a well established technique for computing high purity germanium detector efficiencies for a wide range of sources shapes and size. We examine existing methods for the measurement of uranium, and present preliminary results from an alternative method, which utilizes a combination of detector response modeling and the detection of uranium daughters to calculate uranium concentration. This method is evaluated to determine its applicability to quantitative non-destructive determinations of uranium in natural uranium ores.

We performed gamma spectrometric determination of the uranium content in silicate uranium ores using a HPGe detector (BEGe) 3830 in combination with Canberra’s ISOCS (*In situ* Object Counting System) software. The detector parameters used were: area 38 $cm^2$, width 3 cm, nominal registration efficiency 34 %, energy resolutions (FWHM) is 0.572 keV for the line 122 keV. To model the geometry of the sample we used the Geometry Composer code from the ISOCS software with the following input data: sample diameter 39.9 mm, sample height 11.5 mm, sample mass 25 g, and chemical elements in a sample (Si, Al, Na, Ca, Fe, Mg, K, Mn, P, S, Ti and U). The activity, and hence, the content of uranium in the ore samples was then determined by detection of $^{238}$U daughters $^{234}$Th and $^{234m}$Pa, corrected using the absolute efficiency curve.

We found that using the gamma spectrometry equipment in combination with ISOCS software resulted in uranium concentration measurements from uranium ores of certified composition (ranging from 0.047 to 0.768 % uranium by weight) with better than 6 % relative error (calculated as $1\sigma$). In addition, we found that there is a possibility to conduct such measurements without specification of the full chemical composition of a sample; e.g., for silicate ores, only the presence of Si and U needs to be specified for the model to achieve correct concentration within 8% relative error. Our results support that this method can be reliably applied for non-destructive uranium assay in different types of uranium ores.