Gamma spectra from uranium mining residues simulated for airborne geometries and detectors

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Legacies from uranium mining pose an acute risk to human health and the environment in Central Asia in the countries of Kyrgyzstan, Tajikistan, Uzbekistan and Kazakhstan. This risk is due to the emission of radioactive radiation and the potential contamination of groundwater with radionuclides from the mining residues. A precise knowledge of the location and the contained concentrations of these contaminated sites is necessary in order to obtain an assessment of the hazard and to define areas with the highest remediation priority.

The Federal Institute for Geosciences and Natural Resources in Germany (BGR) currently carries out the project DUB-GEM (Development of a UAV-based Gamma spectrometry for the Exploration and Monitoring of Uranium Mining Legacies), funded by the German Federal Ministry of Education and Research. Within the project, an Unmanned Aerial Vehicle (UAV) based system is to be developed with which the exploration of contaminated sites can be carried out both with low risk for the measurement technician and quickly and cheaply. The challenge lies in the nuclide-specific determination and differentiation of heap and tailing materials with airborne measurements and scintillation detectors. Due to the low spectral resolution of such detectors, this was not possible for a long time. However, with new technologies, scintillation materials and better computer algorithms there is now a potential to solve the problem.

In the DUB-GEM project, one of the detectors to be used will be a large volume (600 ml) CeBr3-detector. In preparation for the field campaign in 2021, we calculated theoretical gamma spectra for this detector using Monte Carlo simulations with the program MCNP6. The simulations were done for varying survey parameters such as flying height and speed, as well as for varying source parameters such as nuclide-specific composition and ground distribution of the mining residues to be mapped. The results of the theoretical investigations will be used to design and optimize survey parameters and to estimate minimum detectable activities.