Abstract

This thesis deals with gamma-ray field of size-limited uranium objects and with possibilities of their localization by a field radiometric measurement. The gamma-ray field attenuates progressively with distance from the ground source of radiation. The applied method of radiometric survey plays an important role in localization of a radioactive object. The gamma-ray field of uranium anomalous objects was studied for variable signatures of ground anomalous objects and different methods of gamma-ray survey by using mathematical modelling. The method of modelling was derived from fundamental theoretical laws describing the gamma-ray field of a point source. The verification of applied mathematical modelling was carried out by the comparison of calculated model of the gamma-ray field at three real uranium anomalous objects with experimental data of ground and mini-airborne measurement. Mini-airborne measurement was realized by the prototype of a gamma spectrometer Georadis D230A. This instrument is characterized by relatively high sensitivity compared to previously used similar devices. Airborne platform was a hexacopter Kingfischer. One of the aims of this thesis was to assess the applicability and technical capacity of D230A instrument. Calculated values of the gamma-ray field at different detection heights, in the interval from zero to forty meters above the ground uranium objects, are in the conformity with experimental data of ground and mini-airborne measurement. The developed and described method for modelling of gamma-ray field over planar arbitrarily defined radiation source is applicable for different height of detection. Possibilities to detect an uranium radioactive object was assessed for circular sources of different diameter in the range from 2 m to 60 m with different uranium concentration in the range from 10 ppm eU to 2000 ppm eU. The variable height of detection from measurement on the ground to 80 m above the ground was considered. Different detector sensitivities and variable exposure time from 1 s to 360 s were considered.

The results of mathematical modelling showed that generally the detectability distance of anomalous object initially grows with increasing detection height, at certain detection height reaches the maximum and with continued increase of detection height the detectability distance of the object declines. At certain detection height, it is not possible to detect the object neither above its center. For localization of a radioactive source it is advantageous to carry out the ground measurement with a detector as high as is possible, around 2 m. Mini-airborne measurement using UAV is possible to realize at flight altitudes from several

meters to several tens of meters. The thesis introduces the relation between the detectability distance of a ground gamma-ray uranium object and variable parameters of the ground object, flight height, and the applied survey method. The detection possibilities of a circular radiation source using mini-airborne survey with the spectrometer D230A were evaluated as very close to possibilities of a standard airborne survey.

The possibilities of localization of model radioactive objects were studied for gamma energy of uranium energy window 1.76 MeV and separately for the total count energy interval. The results showed that detectability distance of the anomalous object is greater for the total count measurement than with using the count rate in uranium energy window only. The difference is up to the first tens of percent. The reason is mainly the higher registered count rate and related precision of the total count measurement.