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Sampling strategy for finding radioactive pollutants in floodplain

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Uranium ore was mined in the area of Ralsko, northern part of the Czech Republic in the last century. One of environmental problems of mining was the discharge of mine waters to the Ploucnice River and consequent deposition of the contamination in floodplain. Another way of the transfer of mining waste into floodplain was a “radioactive” flood in 1981, which washed away a settling pond in the mining area. Finding the hotspots of contamination by uranium and other heavy metals in floodplain was a challenge for us.

The first step in the hotspot imaging was examination of a historical low-resolution map based on aerial gamma spectrometry covering the entire mining area and the Ploucnice River catchment. Spatial resolution of the interpolated gamma activity raster was about 25 m, but the distance between individual neighbouring measurement points was about 250 m. After selecting potential pollution hotspots in that low-resolution map, we visited those sites to perform field survey using handheld gamma spectrometer connected with GPS. The output of this mapping was a net of points with about 11 m steps. Gamma spectrometry itself cannot be used to reliable localization of the subsurface contamination, because this method measure products of radioactive decay of uranium after radon in decay chain and at the same time the contamination was stored in variable depths and the surface activity was attenuated if the pollution was deeper than a few decimetres. Therefore, the third step of work was drill coring followed by in-situ chemical analysis using handheld X-ray fluorescence spectrometer (XRF).

Our system of sampling can be called “double – half”. The core 1 is drilled and analysed in a local maximum of the surface gamma activity. Then core 2 is drilled in the distance of the half of the radius of the gamma activity hotspot. The next point of drill coring (core 3) is placed in double distance from the core 1 in the same direction as the core 2, if contaminants in core 2 are present, or in the half of distance between cores 1 and 2, if contaminants are absent in the core 2. This approach systematically allows minimizing the number of samples without contamination and thus time and money are saved. The last step was a more accurate analysis of uranium and other heavy metals in laboratory after sampling and conventional laboratory sample processing.

The evaluation of spatial distribution of contamination from drill coring may be supported by electromagnetic imaging (EMI) of the pollution hotspot or electrical resistivity tomography (ERT) in the line of samples.