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The use of portable instruments for mapping contaminants in the floodplain of the Ploucnice River (Czech Republic)

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The Ploucnice River (the Czech Republic) was contaminated by uranium mining in the areas of Hamr na Jezere and Straz pod Ralskem mainly in 1971–1987. The pollutants are now deposited all over the floodplain of the river. In 2005 the aerial mapping of radioactive pollution in the floodplain of the Ploucnice River was performed at a height of 80 m above the ground in grid 250 x 250 m. That survey showed uneven, highly localised deposition of gamma-emitting nuclides along nearly the entire reach of the Ploucnice River.

We studied several of those radioactivity hotspots 10–25 km downstream from the uranium mining area in aim to understand the reasons for that heterogeneity. The contamination of the floodplain was analysed mainly by two portable (handheld) instruments. The gamma-spectrometer DISA 400A was used for measuring the total surface gamma activity (main target nuclide was Ra-226). Very effective was also the use of portable X-ray fluorescence spectrometer (XRF) Olympus Innov-X (DELTA Premium), which provides fast analysis of more than 30 elements, such as pollutants (Ba, Ni, Pb, U and Zn) and grain-size sensitive lithogenic elements (Al, Si, Zr, Rb). Besides pollution mapping, XRF also allows for mapping sediment lithology using Al/Si or Rb/Zr element ratios (both proportional to the percentage of fine fraction).

The field gamma spectrometry and XRF was performed with points 2–30 meters spaced, which revealed that hotspots according to low resolution (250 m) aerial mapping is composed of one or several strongly polluted areas with sizes up to several tens of metres. Similarly heterogeneous was also the distribution of sediment lithology in the floodplain. In some cases, micromorphology of the floodplain, formed mainly by the past meander abandonments and channel shifts was responsible for the heterogeneity of the pollution. To understand the floodplain development we used old maps and aerial photographs. The Czech Republic has an extensive archive of historical aerial photos from 1938 and then from 1953 to the present with 5 or 10 years intervals. The maximal contamination was found in places where there was a meander cuts shortly after a flood (>Q50) in1981. Additionally we used digital elevation model (DEM), created from a laser scanning (LIDAR) dataset DMR 5G obtained in 2010 with nominal altitudinal precision of 0.18 m in open terrain and 0.3 in forested terrain.

Our study demonstrated that very detailed, high-resolution analysis of pollution distribution in the floodplain, achievable by portable analytical instruments and interpreted on the base of micro-geomorphology analysis, help to better understand the sedimentation patterns and sediment reworking in fluvial systems.