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Polonium (^{210}Po), lead (^{210}Pb) and uranium (^{234}U , ^{235}U , ^{238}U) contamination of environment surrounding phosphogypsum waste heap in Wiślinka (northern Poland).

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The aim of this study was to examine the concentrations of ^{210}Po , ^{210}Pb , ^{234}U , ^{235}U and ^{238}U in surface soils samples collected in the area of phosphogypsum waste heap in Wiślinka (northern Poland) and assessing its impact on the surrounding environment. Concentrations in analyzed soils samples were estimated between $3.0 \pm 0.2 \text{ mBq} \cdot \text{g}^{-1}$ dry wt. and $324.5 \pm 15.41 \text{ mBq} \cdot \text{g}^{-1}$ dry wt. for ^{210}Po and between $3.6 \pm 0.2 \text{ mBq} \cdot \text{g}^{-1}$ dry wt. and $229.9 \pm 5.4 \text{ mBq} \cdot \text{g}^{-1}$ dry wt. for ^{210}Pb . $^{210}\text{Po}/^{210}\text{Pb}$ activity ratios were in the range of 0.70 ± 0.05 to 2.15 ± 0.13 . The abbreviation may be connected with the agricultural use of fertilizers. The results for uranium suggest that ^{234}U , ^{235}U and ^{238}U radioisotopes that are present in the vicinity of phosphogypsum waste heap are of natural origin ($^{234}\text{U}/^{238}\text{U}$ activity ratio between 0.81 ± 0.08 and 1.22 ± 0.11 , and $^{235}\text{U}/^{238}\text{U}$ between 0.029 ± 0.008 and 0.062 ± 0.013 are typical for soils). The activities of ^{238}U , ^{234}U and ^{235}U ranged from $2.20 \pm 0.17 \text{ mBq} \cdot \text{g}^{-1}$ dry wt. to $108.68 \pm 3.03 \text{ mBq} \cdot \text{g}^{-1}$ dry wt., from $2.31 \pm 0.17 \text{ mBq} \cdot \text{g}^{-1}$ dry wt. to $108.68 \pm 3.03 \text{ mBq} \cdot \text{g}^{-1}$ dry wt. and from $0.08 \pm 0.03 \text{ mBq} \cdot \text{g}^{-1}$ dry wt. to $3.88 \pm 0.57 \text{ mBq} \cdot \text{g}^{-1}$ dry wt., respectively. The highest activities of ^{210}Po and ^{210}Pb were measured in samples collected on both slope and bottom of the phosphogypsum heap. Much lower results were obtained for samples collected from distant areas, what is probably connected with both erosion and leakages from phosphogypsum waste heap into surrounding environment. Lower results for ^{234}U and ^{238}U in the vicinity of phosphogypsum stack in comparison to ^{210}Po and ^{210}Pb activities in this area may be explained by the fact that during the process of phosphoric acid production polonium migrates to phosphogypsum fraction and uranium to phosphoric acid. It is connected to higher solubility of uranium in phosphates. Surprisingly, the highest concentrations of uranium radioisotopes were measured in samples collected from more distant sample collection sites. This fact must be correlated with the use of phosphoric fertilizers in agriculture. For a clearer picture of the radioactive contamination of the area of phosphogypsum waste heap in Wiślinka, we decided to create interpolation maps for every radioisotope using natural neighbor interpolation and ordinary kriging geostatistical method in Spatial Analysis and Decision Assistance (SADA) software. This allowed us to isolate zones that are categorized by different activities of ^{210}Po , ^{210}Pb , ^{234}U , ^{235}U and ^{238}U : the foot of the waste heap, the slopes of the waste heap, agricultural fields and the opposite riverbank of Martwa Wisła river. Additionally, we plotted graphs that described analyzed radioisotopes distribution on the distance from the phosphogypsum landfill. This helped us to isolate the zone described by the highest activities of uranium, polonium and lead radioisotopes.

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