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Concentration Levels, Distribution and Mobility of the Chernobyl ^{137}Cs in the alluvial Soil Profiles in Relation to physical and chemical Properties of the Soil Horizons (a Case Study)

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A study of ^{137}Cs distribution and mobility in alluvial soil profiles was performed in the basin of the Iput' river (Bryansk region) contaminated after the accident at the Chernobyl NPP. Four study plots have been located on the medium and low-level riverside flood plain of the river Iput' and its right tributary Buldynka. Soil profiles were sampled manually and continuously in the increasing increments of 2 to 5 cm down to 50-70 cm below the soil surface. Obtained soil samples were analyzed for the ^{137}Cs specific activity (determined with the help of Canberra gamma-spectrometer), organic matter content (chemical and physical methods), particle-size distribution (standard gravimetrical procedure), absorbed bases (1N CH_3COONH_4, 1:50, pH=6.5), exchangeable potassium and ^{137}Cs (1N CH_3COONH_4, 1:10), mobile iron and manganese (1N CH_3COONH_4, pH=4.8); amorphous iron ($H_2C_2O_4$x2H_2O+ $(NH_4)_2C_2O_4$xH_2O, pH=3.2), clay fraction content (<1 μm, Gorbunov procedure) and its mineral composition (X-ray diffractometer identification). Soils were characterized by sandy texture, high concentration of the amorphous iron hydroxides (2.2$\pm$0.5%psgobile manganese (73$\pm$16 mg/l), considerable cation exchange capacity (34$\pm$8 meq/100 g) and medium to high saturation with bases, remarkable portion of amorphous material in clay fraction and its enrichment in organic substances (7,7-13,1%). Clay fraction composition was noted for hydromica domination (Ìå=50%) and considerable admixture of fine particulate quartz and lepidocrocite.

^{137}Cs activity of soil horizons varied from 0.01 to 31.2 Bq/g, reaching maximum

values in primary contaminated layers buried at the depths of 6 to 40 cm. Radiocesium was found in all granulometric fractions with the highest values in clay and silt: 1) $<1\mu$m - 44.1$\pm$11.5 Bq/g; 2) 1-5 μm – 33.3$\pm$7.6 Bq/g; 3) 5-10 μm – 20.9$\pm$4.9; 4) >10 μm – 2.4$\pm$0.6 Bq/g.

Specific ^{137}Cs activity in clay fractions of highly and medium-contaminated soil layers increased in accordance with the growth of smectite and (or) hydromica shares. In general the presence of clays contributed to ^{137}Cs immobilization (Spearman rank order correlation coefficient between clay fraction content and exchangeable ^{137}Cs r=-0,608, n=17). However it was found that the percent of the latter (found in CH_3COONH_4 extraction) had the increasing tendency corresponding to hydromica portion present in clay fraction. In our opinion this means that these minerals can serve as potential reservoirs of mobile ^{137}Cs forms in sandy alluvial soils. Correlation analysis of the obtained data showed also a significant role of mobile iron in vertical migration and fixation of radiocesium in secondary-contaminated alluvial soils (Spearman correlation coefficient with the total ^{137}Cs content r=0,671, n=18; with the percent of the exchangeable ^{137}Cs content r=-0,716, n=16). Negative correlation tendency was found between ^{137}Cs activity and the amount of exchangeable potassium (acetate extraction r=-0,460, n=16).

Performed case study confirmed that technogenic radiocesium is involved in natural soil processes and its real and potential mobilization is closely connected to the physical and chemical properties of the hosting soil horizons. It can be supposed that dynamic changes of these properties can cause seasonal mobilization of radiocesium and contribute to relatively stable values of the radiocesium transfer factor to local vegetation and food chains observed in the region since 1988-1992.

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