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Analyzing the soil sorption and transfer environmental functions in the South-East part of Western Siberia using Pt and Ni nanoparticles

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The soil with flushing water regime has a very important environmental function, the regulative one in the migration of the dispersed substances caused by natural and anthropogenic activity. The study of these processes is necessary to solve questions of the origins and functioning of soils and also to estimate the parameters of finely dispersed xenobiotics (man-made nanoparticles) accumulation and transfer in the landscapes.
The model substance to explore the ways and potential function of migration in texture-differentiated soils of the southern forest zone of Western Siberia are the suspensions of nanosized platinum (diameter from 5 to 15 nm). The research is based on the properties and behavior of nanoparticles in porous media and their ability to keep highly dispersed state for a long time in the aqueous suspensions due to the small size (up to 100 nm) and low surface charge. Particle identification tags will be conducted using mass spectrometry with inductively coupled plasma. That is possible due to the small percentage abundance of platinum.
Two groups of experiments were conducted with support of RFBR grant №14-04-00967. First one has been done for evaluation the platinum nanoparticles transmission and interception in soil horizons inside undisturbed monoliths. Second group has dealt with the mechanical barriers investigation for nanoparticles behavior in the native Haplic Albeluvisols profiles by standard method application to determine the filtration properties.
The significant variability of detention and transmission values of nanoparticles columns through soil horizons has been detected. There are no simple correlations between the evaluated with the nanoparticles pass-through function through the soil column and soil properties. The main factor that determines the conditions of nanoparticles transfer through the horizon is the geometry of the pore space, and the type of filtering suspensions: linear or front one. Thus, the presences of dead-end pores, a fibrous structure of their sides are strongly inhibiting the nanoparticles movement. It was also revealed that the carbonates presence in the soil horizon helps to latch the vast majority of migratory nanoparticles (up to 95 %).
The field experience has shown that about 65% of platinum nanoparticles migrate beyond topsoil 50-cm layer, forming the largest accumulative maximum in the upper part of the argic horizon (50-60 cm), where about 35% of platinum has been accumulated. The other part of the argic horizon accumulates about 30% of the nanoparticles. The less inert and larger (50 nm) Nickel nanoparticles have been completely latched within 60-cm topsoil.
The soil transfer environmental function depends as on the parameters of the moving matter, as on the soil properties. The presence of preferential pathways for migration with flushing waters increases the depth of finely dispersed substances transfer in the soil. At the same time the front migration and the presence of carbonates in soils limits the potential migration of finely dispersed material.