Transport and filtration of carbon nanotubes in porous media

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Increasing production and use of nanomaterials and lack of regulations for disposal may result in the introduction of nanomaterials to soils and ultimately into groundwater systems. Because the tendency of nanomaterials to deposit on a surface is a key indicator of their fate, bioavailability, and reactivity in aquatic systems, we evaluated the transport behavior of functionalized single-walled carbon nanotubes (SWNTs) in a well defined porous media composed of cleaned quartz sand. Our results show that increasing solution ionic strength results in an increase of SWNT deposition (filtration). This observation is generally consistent with DLVO theory of colloidal stability suggesting physico-chemical mechanisms play important role in SWNT filtration. However, the lack of change of SWNT filtration at low ionic strengths ($\leq$3.0 mM KCl) and the incomplete breakthrough of SWNTs in deionized water indicate that physical straining is an important capture mechanism of SWNTs. It is proposed that the very high aspect ratio of SWNTs and their highly bundled (aggregated) state in aqueous solutions contribute considerably to the straining in flow through porous media. We conclude that both straining and physicochemical filtration play a role at low ionic strength (<3.0 mM), while physicochemical filtration is the dominant mechanism of SWNT filtration at high ionic strength ($\geq$3.0 mM). Because the classic colloid filtration theory does not account for removal by straining, these observations have important implications for the prediction of SWNT fate and transport in subsurface environments.

Manganese soil pollution in Central India

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The native soils in India due to the increased productivity of the crops generally began depleting of the micronutrient (i.e. Mn, Fe, Cu, Zn, etc.) reserves and the crops started responding to micronutrient fertilizers [1]. In central India, the soil metal content levels in the surface soil are increasing due to huge deposition of the minerals and coal and their exploitations. Some micronutrients like Mn is toxic to crops when occurring in excess in soil [2]. In the proposed work, the available and total Mn levels, correlation with other micronutrient, depth profile distribution and toxicities/deficiencies in Raipur area (Chhattisgarh state, India) over $\approx$ 2.0x 10 4 km^2 is described.

The pH of soil is around neutrality or slightly acidic and found to be in the range of pH 4.70-7. The mean value (n=100) of available content of eight micronutrients i.e. Fe, Cu, Zn, Mn, Co, Ni, Mo, and S was found to be 305, 3.1, 1.6, 850, 9.1, 2.8, 1.08 and 200 mg kg^{-1}, respectively. The mean value of total content of micronutrient Fe, Cu, Zn, Mn, Co, Ni, Mo, and S in soils was 14236, 38, 27, 4921, 85, 25, 3.3 and 451 mg kg^{-1}, respectively. The mean ratio of available to total content of micronutrient i. e. Fe, Cu, Zn, Mn, Co, Ni, Mo, and S was 0.03, 0.07, 0.04, 0.18, 0.12, 0.08, 0.13, and 0.55, respectively. Their available concentration in soils of Raipur area was found to occur in the following decreasing order Mn> Fe> S> Co> Cu> Ni> ZN> Mo. Among them, Mn was found to be at the highest level. They showed a positive correlation between the available and total metal content. The total concentration of the micronutrients Fe, Cu, Mn, Co, Ni, and Mo increase with depth profile. The available, and total level of Mn in soils of this region lie in the range of 113–2330 mg kg^{-1}, and 1955–7203 mg kg^{-1} with mean value of 790 and 4764 mg kg^{-1}, respectively. A 5.7 mg kg^{-1} and 55.0 mg kg^{-1} were reported as the critical limit for Mn-deficiency and threshold value of Mn-toxicity for plant growth. All type of soils in this region was found to be contaminated with Mn above permissible limit The symptoms such as i.e. brown or purplish spots on lower part of the stem in cereals and on the leaf margins are commonly seen in this region that may be due to manganese toxicity.

[1] Gupta (2005) *J. Trace Elements Medicine & Biology* **18**, 325 – 331. [2] Marschner (1995) 2nd ed. Academic Press, San Diego, CA.