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Sorption Behavior of PFOS on Soils with Different Physicochemical Properties

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Background/Objectives. Perfluorooctane sulfonate (PFOS, $C_8F_{17}O_3^-$), an emerging pollutant, was found to be extremely environmental persistent, bioaccumulative and toxic to human health and ecosystems. It has been widely detected in groundwater, surface water, soil and sediment; hence it is of significant importance to understand the fate and transport of PFOS. However, very little research has been reported on the PFOS sorption behavior onto soils, one of the primary processes that influence its fate and transport in the subsurface. In this study, the sorption and desorption of PFOS onto six soils with different physicochemical properties were investigated, to explore the relationship between the sorption behavior of PFOS and physicochemical properties of the soils.

Approach/Activities. Six soil samples (0-20 cm) were collected from agricultural land in different provinces, namely Jiangxi (Ferrosols), Guangdong (Ferrosols), Guangxi (Ferrosols), Heilongjiang (Isohumosols), Jiangsu (Cambosols), and Chongqing (Cambosols). PFOS concentrations were analyzed by liquid chromatography-electrospray ionization tandem mass spectrometry (LC-ESI-MS/MS). Equilibrium and kinetic studies of sorption onto six soils were carried out in batch experiments to explore the relationship between sorption parameters and soil properties. The relationship between the sorption capacity of PFOS and the physicochemical properties of the soils was analyzed by multiple linear regressions. FTIR and vis-NIR spectra of soils in the absence and presence of PFOS were also analyzed, to further explore the sorption mechanisms of PFOS to six soils.

Results/Lessons Learned. The results showed that the sorption isotherms can be described by Freundlich model very well for all six soils (R^2=0.968-0.999). The sorption kinetics of PFOS on the six soils demonstrated that PFOS sorption reached equilibrium within 48 h, with the pseudo-second-order rate constants ranging 0.02-0.51 kg/(mg·h). The intra-particle diffusion model results indicate that both film (external diffusion) and intra-particle diffusion were the rate-limiting processes. Among the six soils, Ferrosols had the highest sorption capacity for the PFOS, while Cambosols had the lowest value. Sorption capacity and equilibrium time were influenced by key soil properties such as iron content and total organic carbon.