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Sequestration of PAHs by coal and coal-derived particles in river floodplain soils

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Introduction: The mobility and bioavailability of organic contaminants, such as PAHs depend on the desorption of these compounds from the solid phase to the water phase. In stead of classic batch and column experiments, there are several fast and simple techniques applied for measuring the desorption kinetics from natural solid materials, such as using XAD, and Tenax as the infinite sink for PAHs in the water phase (Cornelissen et al., 1997: Cornelissen and Gustafsson 2004). However, soot and soot-like particles strongly bind to those sorbents, and cannot easily be separated from them anymore, therefore causing the overestimation of the desorption (Jonker and Koelmans 2001). Hence, mild supercritical fluid extraction (SFE) was chosen to mimic water desorption of PAHs and be proved to be a rapid and useful test to predict the bioavailability of PAHs on contaminated soil (Hawthorne and Grahanski 2000). In the present study, we applied SFE to study the desorption kinetics of PAHs from 3 river floodplain soil samples, and these samples have the characteristics of the abundance of coal and coal-derived particles.

Materials & Methods: Physical separation was used, instead of chemical treatment in order to minimize the alteration of geosorbents. In this way, samples were separated into light fractions, heavy fractions, and grain size fractions. The light fraction was analyzed by organic petrography which showed a distinct abundance of coal (vitrite, fusinite, semifusinite) and other coal-derived particles such as coke. Most of them are in the form of vitrite from sub-bituminous coal, raw sub-bituminous coal and a relatively high amount of carbon-rich clayey matrices containing very small (few microns in size) coal and coke particles. Possible sources of the coal particles and the coal industry related carbonaceous particles are shipping activities on the river near the

sampling site, coal mining and coal industry in the neighboring region.

Results: Mild supercritical fluid extraction of original soils, light fractions, and < 63 μm fractions were performed to mimic the contamination free water desorption study of these river floodplain soils. Slow and very slow desorption of PAHs were found for all the samples and could be resulted from sequestration of PAHs by the coal and coal derived particles in our samples. The difference of desorption behavior of Nap and its methylated compounds could be resulted from the impact of coal particles in our samples. Two-site model (Cornelissen et al., 1997) fit our investigated data well. Fast desorption fraction were smaller compared to results of other nature sediments from other studies, while much larger than those for soot and soot-like material. Desorption rate constants indicated the slow, very slow, and even extremely slow desorption from these samples, which could be dominated by coal and coal-derived materials. Years, decades were estimated for the 99 % releasement of native light and medium molecular PAHs such as Nap, Phen, and Fth from these samples, while for some 5, 6 ring PAHs, centuries, and even millennia were required.

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