

包气带土壤组成对三氯乙烯的吸附影响研究

The influence of soil constitution on the sorption of trichloroethylene in the vadose zone

中文关键词: [包气带](#) [三氯乙烯](#) [吸附](#) [粘土矿物](#) [有机碳](#)

英文关键词: [vadose zone](#) [trichloroethylene](#) [sorption](#) [clay minerals](#) [organic carbon](#)

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中文摘要:

有机质和矿物质是包气带土壤中的主要吸附介质, 其吸附特性直接影响有机污染物在环境中的迁移、转化等过程。分别采用分析纯石英砂和典型粘土矿物高岭石模拟土壤的原生矿物和粘土矿物, 利用批实验的方法研究土壤中各组成部分对三氯乙烯(TCE)的吸附行为。土壤有机质的吸附行为通过全土样和矿物质的对比得出。结果表明, 粘土矿物是吸附氯代烃的主要矿物质, 原生矿物对氯代烃的吸附量很小; 土壤有机质含量和土壤吸附量之间有很好的正相关性; 土壤有机碳含量与土壤粘土矿物含量的比值是影响吸附行为的另一重要因素, 比值越小, Koc值越大, 土壤对TCE的亲合力就越强。由于自然界中的土壤有机质大都与矿物质形成有机质-粘土矿物结合体, 据此推测有机质-矿物质结合体会影响有机质的组成和形态, 从而对其吸附行为有重要作用。

英文摘要:

Chlorinated hydrocarbons (CHs) are widespread organic contaminants in the groundwater system. Among them, trichloroethylene (TCE) is most common. Since TCE is a typical DNAPL (dense non-aqueous phase liquids), it tends to migrate downward into the groundwater system where pools exist. During the migration of trichloroethylene in the vadose zone, soil sorption plays an important role in determining its mobilization, transportation and accommodation. Soil organic matter (SOM) and soil minerals are two major sorbents in the vadose zone which strongly affect sorption behaviors of organic contaminants. Based on batch experiments, the authors studied the adsorption behaviors of trichloroethylene (TCE) in four simulated mineral samples with different ratios of silica to kaolinite (representing respectively primary minerals and clay minerals) and six soil samples with different ratios of total organic matter (TOC) to clay minerals which were collected at different depths of the vadose soil profile. Instead of employing the isolation procedure of SOM which might cause changes in physicochemical properties of SOM, the sorption behaviors of TCE in SOM were predicted by the comparison between soil samples and simulated soil mineral samples. The results obtained show that both the sorption isotherm of soils and that of minerals fit Langmuir sorption model. The maximum sorption capacity of pure kaolinite is nearly 200 $\mu\text{g}/\text{kg}$, while that of pure silica is only about 15 $\mu\text{g}/\text{kg}$. The maximum sorption capacity of clay minerals is almost 13 times as large as that of primary minerals. The clay minerals contribute most of the sorption capacity of soil minerals, while the primary minerals only present negligible sorption of TCE. The content of TOC is the key factor affecting the sorption of TCE in soils, as the sorption capacity of TCE in SOM is several orders of magnitude larger than that in clay minerals, which accounts for the positive correlation between the content of TOC and the soil sorption capacity. The ratio of TOC to clay minerals is another factor affecting the sorption behaviors of TCE in soils. Soil with lower ratios of TOC to clay minerals would produce higher Koc values. SOM has been reported to be intimately associated with the clay mineral fraction and widely distributed in the environment in the form of organo-clay complexes. The thickness of SOM coating on clay minerals decreases with the decrease of the ratio of TOC to clay minerals on the uniform organo-clay complexes, and the molecular layers close to the mineral surface may take a more compacted form due to the attractive power of mineral surface. Any SOM layer beyond this compacted region may be relatively intensely expanded as the attractive force becomes weaker with the increasing distance from the mineral surface. Therefore, the proportion of the bound SOM in the condensed form would be relatively high at the lower ratio of TOC to clay minerals. Soil with lower ratios of TOC to clay mineral is likely to produce higher Koc values indicating an increasing affinity of TCE for the soil, which suggests that organo-mineral complexes potentially play an important role in regulating the accessibility and distribution of sorption sites for organic chemicals, and are thus important in the study of sorption mechanism.

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