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MATRIX-IMMOBILIZED ORGANOCCLAY FOR THE REMOVAL OF PAHS AND
PENTACHLOROPHENOL FROM GROUNDWATER

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Previous research in this laboratory has shown that multifunctional clays can be tightly immobilized onto the surface of a solid support. These porous composite materials are effective in the removal of toxic contaminants from groundwater. In this study, various composites were tested to determine their effectiveness in the remediation of pentachlorophenol (PCP) and a variety of PAHs. These composites include: 1) cetylpyridinium (CP) electrostatically bonded to sand; 2) CP-exchanged low pH montmorillonite clay (CP-LPHM) bonded to sand using the free acid form of carboxymethylcellulose (H-CMC) as an adhesive; 3) CP-LPHM bonded to granular activated carbon (GAC) using H-CMC as an adhesive; and 4) CP-LPHM bonded to silica beads using chitosan as an adhesive. Bench studies measuring the removal of ¹⁴C-PCP from a complex solution of oil suspended in water showed that neither silica beads nor sand as solid support matrices provide the added adsorptive capacity of GAC. Although the use of adhesive materials provided greater hydraulic conductivity, neither chitosan nor H-CMC provided additional adsorptive capacity for PCP or the PAHs analyzed in this study. In fact, H-CMC decreased the capacity of GAC for the contaminants. The composite of CP-LPHM bonded to silica beads with chitosan as an adhesive showed the greatest capacity for the contaminants and was therefore further tested in field studies at a creosote-contaminated Superfund site in the northwestern United States. Identical glass columns were filled with a volume of composite equal to that of 5 g of GAC and covered with sand and glass wool. Effluent from an oil-water separator was continuously eluted through the columns over at least 20 h and collected as 1 L samples. These samples were extracted by affinity using a binary solid phase and quantitatively analyzed for PCP and PAHs by GC/MS. After 27 h of continuous flow this composite reduced the contaminant load of phenanthrene from a maximum of 50,098 ± 8,179 ppt to 1,800 ± 901 ppt and pyrene from a maximum of 983 ± 268 ppt to 44 ± 13 ppt. A 50% breakthrough of naphthalene was achieved after approximately 2 h and PCP after 12 h. These results demonstrate that although this composite is effective for PAH removal, it is more effective for those PAHs with higher molecular weights. Therefore, a composite of CP-LPHM bonded to silica beads with chitosan may be useful as a pre-polishing step prior to GAC treatment as part of an effective strategy for reducing high concentrations of PAHs and PCP in groundwater. (Supported by NIEHS P42-ES04917 and TAES H6215.)