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中文题名	泥沙颗粒吸附解吸特性及受污染底泥修复研究
英文题名	Adsorption-desorption Characteristics of Sediment and Remediation of Contaminated Sediment
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中文文摘	泥沙颗粒对天然水体中复杂理化过程有重要影响，颗粒表面的电化学作用使其吸附效应较为显著，会吸附水体中的各种环境物质，如氮磷营养盐、重金属和有机、无机污染物等，其耦合作用影响着污染物的存在形式和迁移转化过程，因此，泥沙颗粒的环境效应得到越来越多的关注。天然泥沙是由多种矿物组成的复杂组合体，包括石英、长石、黏土矿物及铁铝氧化物等，本文基于泥沙主要组成矿物，分析泥沙颗粒与磷（P）之间的相互作用，对于水环境的影响及产生的效应，探究受污染泥沙修复技术的效果。设计天然泥沙颗粒的主要组成矿物与磷的吸附和解吸实验，分析不同矿物对天然泥沙颗粒吸附及解吸的贡献率，包括石英砂、赤铁矿、钾长石、方解石和高岭土等黏土矿物。结果表明，不同矿物对磷的吸附量和解吸率差别较大。除泥沙颗粒自身基本性质（矿物组成和粒径等）影响外，泥沙对磷的吸附行为还受到水体中多种环境因子的影响，如初始磷浓度、溶液 pH 值、离子强度、含沙量等。在综合考虑泥沙自身基本性质和外部环境因子对泥沙颗粒吸附磷影响的基础上，推导出可定量计算不同水环境条件下泥沙颗粒对磷的吸附量，为水体中磷元素输移动态预测提供基础，对从机理上认识磷在水体中的迁移转化过程和水环境效应十分重要。在吸附与解吸实验的基础上，探索将污染水体修复中的纳米零价铁应用到污染底泥修复中，本研究设计了纳米零价铁（nZVI）对泥沙颗粒上已经吸附磷的固化实验，分析 nZVI 对磷的固化率。结果显示，结果显示，对于不同种类的矿物，随 nZVI 添加量的增加，磷的固化率逐渐提升，当添加量大于 0.03~0.05g/g 时，磷固化率趋于稳定，最高可达 86%。磷固化率的提升使得其释放到水体中的释放量下降，表明泥沙颗粒上已吸附磷被再次释放的风险逐渐降低。在污染泥沙颗粒中加入 nZVI 新型固化剂为泥沙原位/异位修复提供了新思路。从降低受污染泥沙起动和不造成二次污染源的思路出发，提出受污染底泥陶粒化回填方法，即将疏浚出的受污染底泥预处理后，烧成陶粒回填至原疏浚区域。通过室内水槽实验，验证该方法的可行性和修复效果。结果显示，该方法直接采用了原区域的疏浚底泥，不仅避免了原位覆盖引入外来材料，也避免了大规模占用土地，可有效解决疏浚底泥的出路，最重要的是也解决了底泥内源污染问题，为河湖生态治理提供了一种新方法。
外文文摘	Sediment particles widely exist in natural waters such as rivers, lakes and reservoirs, and have an important impact on complex physico-chemical processes. The electrochemical properties of sediment lead to significant adsorption between sediment and pollutants such as nutrients, heavy metals and organic/inorganic pollutants, thus affecting the migration and transformation of pollutants. Sediment is a complex assemblage of various minerals, including quartz, feldspar, oxide, and clay minerals. In this study, we take phosphorus as an example to analyze the interaction between sediment and phosphorus considering the main constituent minerals, and then the remediation methods of contaminated sediment are further explored.The phosphorus adsorption and desorption experiments of natural sediment and its main constituent minerals are conducted, including quartz, hematite, potassium feldspar, calcite, kaolin, illite and montmorillonite, and the contributions of these minerals to the adsorption and desorption properties of natural sediment are analyzed. The results show that different kinds of minerals have great differences in the adsorption capacity and desorption rate of phosphorus. In addition, a formula of phosphorus adsorption is proposed comprehensively considering the intrinsic properties of sediment (e.g., mineral composi

	tion, particle size) and the external environmental factors such as initial aqueous phosphorus concentration, pH, ionic strength, sediment concentration, and organic matter, which can accurately predict the adsorption of phosphorus under different aqueous environments, and provide a basis for phosphorus dynamics prediction.Based on the above adsorption and desorption studies, we further explore the application of nZVI in the remediation of contaminated sediment. The solidification experiments of the adsorbed phosphorus by nZVI are conducted to analyze the solidification effects of nZVI from the view of mineral composition. The results show that the phosphorus solidification rate gradually increases with the increasing amount of nZVI, which corresponds to a decreasing risk of phosphorus release into the surrounding water. When the amount added is more than 0.30 g, solidification rate tends to be stable (about 86%). It indicating that the risk of phosphorus adsorbed on particles being released into water decreases gradually. It provides a new method for remediation of contaminated sediment. Moreover, a sediment remediation method of Contaminated Sediment Backfill Technology (CSBT) is proposed based on the idea of reducing the contaminated sediment incipient and not causing secondary pollution sources. That is, the dredged sediment is calcined into ceramsite after pretreatment (e.g. dewatering, detoxification), and then backfilled to the dredged area as a sediment cap, which combines the advantages of sediment dredging and in-situ capping. The potential effects and feasibility of sediment remediation by CSBT are also explored through flume experiments. The results show that this method can effectively solve the problem of internal pollution. It uses the dredged sediment from the original area as the capping material, thus avoiding the introduction of foreign materials. Meanwhile, there is no need to occupy a large scale of land, which effectively solves the problem in the treatment of dredged sediment. Overall, the proposed CSBT provides a new method for the remediation of contaminated sediment.
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