

Iron mineralogy determines the phosphate immobilisation efficiency and redox stability of Fe(III)-rich amendments

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European lowland rivers are afflicted with high phosphate (PO_4) concentrations and rarely meet the ecological target concentrations. Ferric iron (Fe(III))-rich amendments can be added to rivers to immobilise the PO_4 in the sediment and lower eutrophication risks. However, different Fe(III)-rich amendments differ in physicochemical properties and Fe mineralogy, hence differing in PO_4 immobilisation ability and Fe redox resistance under reducing conditions. In this study, we investigated the key properties determining the PO_4 immobilisation efficiency and Fe stability of Fe(III)-rich amendments. Eleven Fe(III)-rich amendments were collected from drinking water treatment plants and acid mine drainage. They were first characterised by selective Fe oxides extractions. Then the PO_4 sorption potential of the Fe(III)-rich amendments was evaluated by performing adsorption experiment. Here it was found that the oxalate extractable Fe content in Fe(III)-rich amendments determined their PO_4 sorption potential (K_D) under aerobic conditions. Finally, the Fe(III)-rich amendments were subsequently mixed in a river sediment at an equal dose of oxalate extractable Fe and incubated in a static anoxic system. The Fe(III)-rich amendments largely reduced PO_4 release from sediment by factors 30-420. Furthermore, the variation in PO_4 reduction extent was determined by K_D and oxalate extractable P/Fe molar ratio of the Fe(III)-rich amendments. The addition of Fe(III)-rich amendments had different impact on Fe mobility, with higher Fe release in Fe(III)-rich amendments containing a higher ascorbate reducible Fe fraction. Based on these results, we suggest selecting Fe(III)-rich amendments with high oxalate extractable Fe but low ascorbate reducible Fe content to be used for sediment remediation.