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Application of iron-containing water treatment residuals for phosphate binding in water treatment and in natural aquatic systems

THILO BEHRENDS[1], MELANIE MÜNCH[1], VICTORIA BARCALA[2] AND ANDREAS VOEGELIN[3]

[1]Utrecht University
[2]University of Applied Sciences Utrecht
[3]Eawag, Swiss Federal Institute of Aquatic Science and Technology

Excess supply of phosphorus to surface waters is one of the main obstacles in improving the quality of surface waters in Europe and other parts of the world with intensive agriculture. In the H2020-MSCA-ITN project P-TRAP, we have been investigating the application of iron-containing water treatment residuals (Fe-WTR) to reduce the flux of phosphorus into surface waters. Applications included the use of sand coated with Fe (oxyhydr)oxides as a reactive barrier around drainage systems or in permeable filters to remove dissolved phosphate from water streams. Furthermore, the suitability of adding Fe-WTR to shallow peat lakes was investigated to reduce the phosphate flux from the sediment to the overlying water.

In these projects, we used synchrotron-based X-ray techniques to investigate the binding of phosphate to Fe-WTR and the fate of Fe-WTR in aquatic sediments when being subjected to biogeochemical reactions. The techniques included bulk X-ray absorption spectroscopy (XAS) at the Fe and P K-edges in combination with micro-beam XRF and XAS analyses. The use of these techniques allowed us to explore 1) the spatial distribution of P binding in the heterogeneous Fe-containing coatings of sand grains, which were used as filter materials, 2) the extent of transformations of Fe-WTR, for example as a consequence of redox cycling or aging, when buried in peaty sediments, or, 3) the nature of P-containing Fe precipitates forming at the sediment-water interface upon Fe-WTR treatment of shallow lakes. The presentation will focus on the potential but also limitations of the applied synchrotron-based X-ray techniques to achieve the related research objectives.