DOER research developed new technology to reduce per- and polyfluoroalkyl substance (PFAS) bioavailability in sediments using 3D printable zeolite-clay composites

ERDC Environmental Laboratory researchers published the results of a novel technology that provides a capability to use moderately contaminated dredged sediment to treat itself. Specifically, the research used 3D-printed composites made of natural materials (clay and zeolite) to reduce 80-95% of PFAS from water and sediment, reducing PFAS biological uptake into tissues by 34-85%. As these 3DP zeolite structures were successful in reducing multiple PFAS analytes from sediment, they represent a promising option for further research and development on scalability and effectiveness in a field setting to reduce PFAS mobility and risk.

As per- and polyfluoroalkyl substances (PFAS) pose a global environmental threat, effective and practical methods for reducing PFAS risk are crucial. To test the effectiveness of this novel treatment for PFAS in sediment, 3D-printed (3DP) structures made of clay and a zeolite known to adsorb PFAS were inserted into a sediment collected from a PFAS impacted site and a sediment spiked with PFAS for 14 days concurrently with organisms that live in sediment. Free zeolite powder and 3DP structures containing only clay (and no zeolite) were also tested to investigate effects of zeolite and the 3DP structures separately.

Both zeolite treatments proved effective in reducing PFAS, with total (∑) PFAS reductions for the 3DP zeolite treatments up to 80-95% in sediment and water, and >99% in the sediment porewater and overlying water of the free zeolite powder treatments. By reducing PFAS from the sediment and water, the 3DP zeolite also decreased PFAS uptake into the organisms, with a 34% and 85% reduction of ∑PFAS in amphipod tissue from the field and spiked treatments, respectively. Using 3DP structures rather than the zeolite powder was advantageous because (1) the structures were easier to insert and remove from the contaminated sediment and (2) the free zeolite powder itself (but not the 3DP structures) were physically harmful to the test organisms.

This was the first published study using zeolite for the treatment of PFAS in sediment, 3D-printing zeolite for treatment of contaminated sediments, and demonstrating 3D-printing as a method for reducing the toxicity of fine sorbent particles. The results of this study suggest 3DP zeolite could be a promising technology for removal of PFAS from contaminated sediment. Future studies should further investigate the scalability and deployability of using these devices for PFAS treatment and remediation purposes.

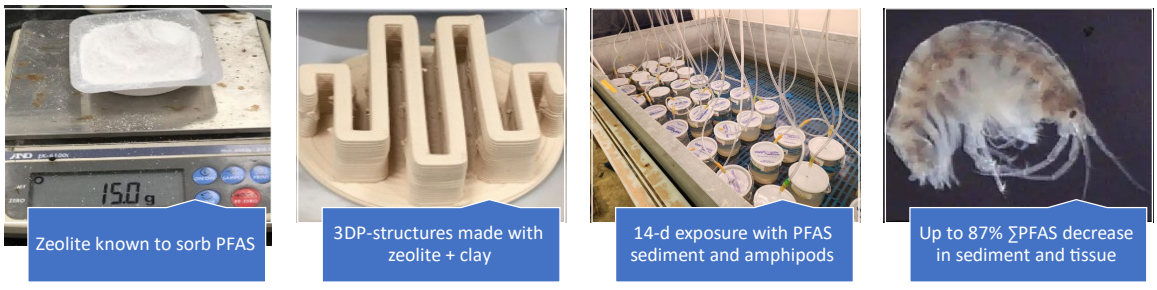

Figure 2. Graphical abstract summarizing the study.

Figure 3. Photographs of the 3D-printed zeolite-clay composites used in the study.

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