Active caps for remediation of mixture of contaminants and resistance to erosion (SERDP, ER-1501)

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Current technologies for remediating contaminated sediments include removal followed by treatment and disposal; in situ isolation of the sediments by covering them with a sand or gravel cap (i.e., passive capping); and monitored natural recovery which involves monitoring natural processes that isolate, degrade, transform, and immobilize contaminated sediments. However, these remedial alternatives offer only temporary solutions, do not address a large variety of contaminants, may not be applicable in both marine and fresh waters, and may be destructive to the benthic environment. There is an acute need for remedial technologies that address a variety of contaminants in a broad range of aquatic environments, provide more permanent solutions by reducing contaminant toxicity, and have less impact on benthic habitats.

The objective of this study is to design in situ treatments for sediments by combining chemical and biological amendments to develop an active capping technology that contains and stabilizes a large range of contaminants in different aquatic environments (including marine and fresh waters). The proposed system will simultaneously reduce contaminant toxicity and/or bioavailability while creating a barrier that is resistant to mechanical disturbance, thus combining many of the advantages of active and passive methods.

This research identified amendments that sequester and retain mixtures of contaminants under a broad range of environmental conditions. Apatite, organoclays, and biopolymers effectively removed metals from both fresh and salt water and exhibited high retention (80% or more) of most metals indicating reduced potential for metal remobilization. Biopolymer products suitable for inclusion in active caps include chitosan/guar gum cross-linked with borax and xanthan/chitosan cross-linked with calcium chloride. Slurries of sand coated with these biopolymers can produce a barrier that resists mechanical disturbance. Modeling studies showed that active caps composed of apatite or organoclay have the potential to delay contaminant breakthrough due to diffusion by hundreds of years or more compared with passive caps composed of sand. The accomplishments of this research have been to identify the best active cap materials; determine the effects of active cap components on metal bioavailability, retention, and toxicity; and identify biopolymer products that impart erosion resistance to active caps.