Engineering Optimization/Validation of In Situ Reactive Cap for TPH-, PCB- and Hg-Impacted Sediment Site in Southern Coastal Europe

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Background/Objectives. In situ sediment capping remediation systems mitigate the environmental impact of resident contaminants. Two general approaches are possible: i) passive capping, which is the deployment of a barrier of material that is relatively impermeable to both the water above and the contaminants below, and ii) active/reactive capping, which exposes contaminants to one or more additives or amendments to address source and impacted porewater as it migrates through the treatment area. The choice of approach depends on a wide variety of site-specific issues. One resulting complication of any sediment capping or the addition of reactive reagent is that the implementation/construction processes themselves typically create an initial spike of methanogenic activities because the sediment becomes disturbed and available carbon sources are more rapidly consumed. A second methane spike can occur later as oxygen is depleted from the remediation site, thus shifting the balance between aerobic biodegradation and anaerobic degradation in favor of the methanogenic anaerobes. These can have significant, negative consequences such as: i) methylation of heavy metals increasing their toxicity and mobility, and ii) induced contaminant migration via ebullition.

Approach/Activities. Provect-CH4® is a proprietary amendment for environmental remediation applications that effectively inhibit methanogens while permitting other biodegradation processes to occur. These antimethanogenic reagents (AMRs) have been combined with AquaBlok®/AquaGate™ technologies to yield composite particles containing an aggregate core that is layered with reactive amendment materials and deployed through a water column over a contaminated site. When applied in situ the resulting permeable reactive cap simultaneously treats contaminants while controlling methane production, which addresses both ebullition of gasses and methylation of heavy metals.

Results/Lessons Learned. Marine sediment at an industrial site in southern coastal Europe is impacted by elevated concentrations of petroleum hydrocarbons, PCB, and mercury (along with other heavy metals). Conceptual remedial designs entail a combination of dredging, capping and natural attenuation based on contaminant type and concentration. Laboratory tests were conducted to evaluate the effectiveness AquaGate as an in situ capping technology and delivery vehicle for various amendments to yield effective treatment. Columns were prepared with marine sediments and sea water collected from an area of interest. Above the marine sediments a sequence of different layers were positioned to simulate the installation of a horizontal permeable, reactive cap with different combinations of AquaGate, AquaGate+CH4 (with methanogen inhibitors), AquaGate+ZVI (with zero valent iron), and AquaGate+PAC (with fine-grained activated carbon). Monitoring of concentrations in column effluents and sediments highlighted the reduction of the contamination, with a clear correlation associated between the composition of the layer placed in the columns and effectiveness. Design and installation options for field -scale (pilot) application will be presented.