In Situ Capping of Sweden's Fiberbanks: Will Remedies Established for Minerogenic Sediments Also "Work" on These Organic-Rich Sediments?

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Background/Objectives. Since the early 1800s, Sweden's paper and pulp industry has made significant contributions to regional and national economies, but a legacy of their past activities threatens the environment. Prior to regulatory requirements, factories discharged untreated wood-fiber waste along with processing chemicals (including PCBs, PAHs, dioxins, metals and metalloids) into surface waters. The material plus bound contaminants settled and accumulated to create "fiberbank deposits". These organic-rich deposits, which also occur in other countries, are found in many Swedish counties, and efforts to characterize their extent and other in situ properties are ongoing. Risk assessments are still being conducted and results will likely indicate unacceptable risks occur at many fiberbank sites, risks that will need to be managed. Fiberbank remediation is in its infancy worldwide, and it is unknown if already internationally-established in situ sediment remedies can also be effectively applied to manage risks associated with fiberbank sediments. Certain inherent characteristics of these anthropogenic deposits (including relatively high gas production, low bearing strength, and low geotechnical stability) may differ substantially from "typical" mineral-based (minerogenic) contaminated sediments, perhaps to the point that in situ capping remedies developed and used for decades on minerogenic sediments may not be directly applicable for also managing fiberbank sediments. To that end, a three-year research project called FIBREM (funded by VINNOVA) is underway to evaluate, first at laboratory scale, the applicability of established in situ capping remedies for managing risks associated with fiberbank sediments.

Approach/Activities. Tests using transparent columns and tanks of different dimensions have been (and are being) conducted to evaluate the effectiveness of selected in situ capping remedies in meeting typical cap-performance objectives, including physical and chemical contaminant isolation. As a critical precursor for meeting such objectives, the geotechnical stability of capped fiberbank sediment, including on slopes, is also investigated.

Results/Lessons Learned. Testing to date has involved constructing conventional granular caps at different thicknesses (5, 15, 30 cm) overtop two different types of fiberbank sediment (finer versus coarser [chippy] particle-sized wood fibers). Early on, it became clear high sediment-gas production at room temperature required all testing to be conducted at significantly colder temperatures (at or near 4 °C) more representative of in situ field conditions. Testing continues, but some noteworthy observations (visual, physical) from testing in 10 cm diameter columns include: (a) gas production is highly temperature-dependent, as noted above, (b) both sediment types produce significant amounts of gas (CH_4, CO_2, H_2S) at the colder temperatures, both before and after capping, (c) consolidation-induced porewater advection seems to be enhanced or accelerated by sediment gas formation and ebullition; gases replace porewaters in sediment pore spaces then essentially "push" the waters upward along with and/or ahead of the migrating gas front, (d) this mechanism for gas-facilitated porewater transport seems especially pronounced when capping the finer sediment, and (e) gas migration eventually results in porewater transfer into and through caps. Overall, results to-date collectively imply gas-facilitated contaminant transport in capped fiberbank sediments may be at least as important as diffusive and advective transport mechanisms. In an effort to confirm such

implications, follow-up testing in much larger (40 cm diameter) columns will include chemical testing to estimate contaminant fluxes before, during, and after capping.