In-Situ Clay Formation: A New Technology for Stable Containment Barriers

Cleanup
CU-1093

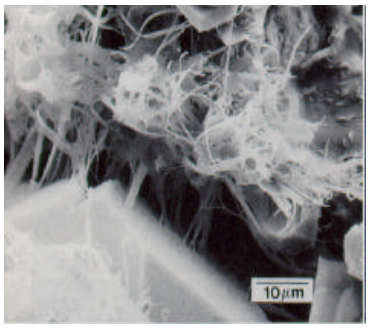
Background:

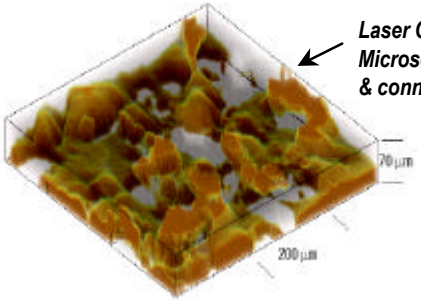
Clays have the advantage of being geologically compatible with the near-surface environment and naturally sorptive for a range of contaminants. The precipitation of clays in-situ in soils and sediments should result in reduced permeability and hydraulic conductivity and increased mechanical stability through the cementation of soil particles. By analogy with natural diagenesis in sedimentary rocks, the researchers intend to engineer "artificial" lithification in soils and sediments. Unlike natural diagenesis, however, the time-scale for clay growth will be accelerated greatly from more than tens of thousands of years to only a few weeks.

Objective:

This project intends to precipitate clays and clay-like solids in-situ using porous geologic materials by building on the technologies that exist for colloidal or gel stabilization. Unlike colloidal or gel barriers, a precipitated-clay barrier does not require saturated conditions to be functional.

Illite bridging pore throat in a sandstone.





Laser Confocal Scanning Microscopy: 3D pore structure & connectivity

Summary of Process/Technology:

The technical approach is multi-disciplinary and involves plans to accomplish the following: (1) confirm published results suggesting that clays can be precipitated in a few weeks to months from aqueous gels; (2) design an optimal gel composition that will maximize clay yield and crystallization rate while maintaining injectability into porous soils and sediments; (3) test the barrier formulation in laboratory experiments; and (4) test the method in a field experiment.

Benefit:

The results from this project will yield a new barrier technology that potentially possesses broader mechanical and chemical stability and, therefore, can be applied in a wider range of environments. The new barrier technology also should provide greater longevity, requiring less maintenance over the long term and less risk of remediation because of barrier failure or leakage. Total cleanup costs to the Department of Defense and Department of Energy should be reduced substantially because of the longer life span of the barrier.

Accomplishments:

In FY 1999 the team synthesized clay (kaolinite) and clay-like solids (hydrotalcite and mesoporous silicates) in the laboratory under ambient conditions in less than several weeks. The general optimal solution compositions from which these solids can be precipitated have been identified. Measurement of the chemical stabilities of all three types of materials has been initiated. The sorption capacity of the mesoporous silicates for hydrophobic organic compounds in aqueous solutions has been determined and found to be similar to that of organo-intercalated smectite clays. Nucleation of clays in quartz grain surfaces has been determined to occur within less than one week under ambient conditions.

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