Influence of groundwater chemistry on the aging of silica gels

Assessing geochemical interactions and secondary mineral formation

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Research group: Geochemistry
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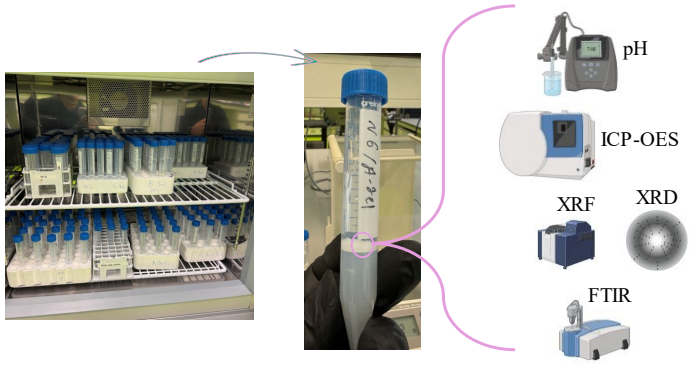

Project description

Project overview:

Silicate grouting is a widely used technique for reinforcing sandy soils and controlling groundwater flow. The injected sodium silicate–based grout solidifies into a silica gel that fills soil pores, reducing permeability and increasing strength. However, once formed, these gels remain in long-term contact with groundwater, whose variable chemical composition can influence their stability. Understanding how environmental factors affect gel aging and degradation is essential for predicting the durability and environmental impact of this technique. This project focuses on evaluating how groundwater composition controls the chemical and structural evolution of silica gels under subsurface conditions.

Research objectives:

- Assess the impact of groundwater chemistry (ion type, concentration, pH, and ionic strength) on the aging and dissolution of silica gels.
- Quantify the chemical evolution of the surrounding water and identify leached components.
- Characterize new mineral phases or precipitates forming at the gel–water interface.

Methodology:

After preparing the silica gels under controlled laboratory conditions, each gel will be exposed to synthetic groundwater solutions with systematically varied chemistries. Thirteen different salts will be dissolved in water to generate solutions representing a range of environmental conditions, including variations in ionic strength, major ion composition, and pH. Over several time intervals, effluent water samples will be collected for chemical analysis. The following analyses will be conducted: (i), ICP analysis to quantify dissolved elements and assess leaching rates. (ii), XRF, XRD, and FTIR analyses of solid residues to identify secondary minerals or precipitates formed through reactions between the gel and groundwater ions. Together, these analyses will provide a comprehensive understanding of how different groundwater chemistries affect the aging and stability of silica gels.

Student role and expected outcomes:

The student will assist in preparing groundwater solutions, conducting gel aging experiments, and collecting and analyzing samples over time. They will perform routine pH and mass measurements, assist in preparing samples for ICP, XRF, XRD, and FTIR analysis, and help interpret the results. Through this project, the student will gain valuable experience in experimental geochemistry, materials characterization, and environmental hydrogeology. The outcomes will enhance understanding of the long-term performance and environmental compatibility of silicate grouts used in soil stabilization.

Job requirements

Interest in geochemistry or hydrogeology, basic laboratory experience (training will be provided).