

Hydrogeology of silica gels in the subsurface

Experimental research into the gelation, mechanical strength, and microstructure of silica gels for soil reinforcement

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Project description

Project overview:

Silicate grouting is a widely applied ground-improvement technique used to strengthen sandy soils and reduce their permeability. In this process, a mixture of sodium silicate, water, and a hardener is injected into the soil, where it fills pore spaces and gradually solidifies into a gel. The gel binds sand grains together, forming a cement-like structure that improves stability and reduces groundwater flow. Despite its long-term use, the fundamental processes controlling gel formation and mechanical evolution in the subsurface are still poorly understood. This project aims bring insight into the gelation of the silica gel under subsurface condition.

Research objectives:

- Investigate the gelation process through measuring gelation time.
- Measure the mechanical strength and stiffness of gel and sand columns.
- Characterize gel microstructure using Scanning Electron Microscopy (SEM).

Methodology:

Experiments will be conducted in the Multiscale Porous Media Lab, part of the GeoLab facilities. The student will prepare sodium-silicate mixtures with varying compositions and monitor gelation time and viscosity evolution using visual observation. Once gels are formed, their mechanical properties will be quantified using compressive test, while SEM will be used (by operator) to image their internal microstructure.

Student role and expected outcomes

The student will receive full training and work closely with PhD candidate from the SilPit team. Tasks include conducting laboratory experiments, recording and interpreting measurements, preparing short presentations, and discussing results in project meetings. The student will gain hands-on experience in experimental hydrogeology, materials testing, and data interpretation.

Job requirements

Basic laboratory experience and strong motivation to learn.



Fig. 1. Preparation of the sand-silica gel samples for gelation time and mechanical test measurements.