Hydrogeology of silica gels in the subsurface

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

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Project description

Silicate grouting is a technique used to improve soil strength or reduce permeability of sandy soils and is one of the most popular methods for in-situ treatment. In this technique, a mixture of sodium silicate, water, and hardener is injected into the soil to fill its pores. The mixture will become gel as the grout solidifies, acting like cement to bind and strengthen sand grain. Although this technique has been used for decades, little is known about the underlying processes and the long-term stability of the gel underground.

This project proposal for a Bright Mind Assistantship is part of the SilPit project in the Hydrogeology Group at the Department of Earth Sciences. This project aims to gain insight into the erosion behavior of silicate gels in the subsurface, to enable assessments of the environmental impact and the life-time of gels. This assistantship focusses on the gelation process of silicate grout of so-called hard gels, which are used for increasing soil strength. The project will be conducted in the Multiscale Porous Media Lab, part of the GeoLab, and will be supervised by our SilPit project team with daily and hands-on training by two PhD candidates, Mohammad and Kim.

During the project, we will investigate the mechanical strength, microstructure, and degradation of the gel. To achieve this, we will investigate the gelation time, rheology (observing viscosity and appearance) and the mechanical strength, using Dynamic Mechanical Analysis (DMA). In addition, we will investigate the porous structure of selected gel samples by Scanning Electron Microscopy (SEM), to understand the gel's microstructure. Those measurements are done by an specialized operator, but we encourage the student to join and observe the technique.

Based on our measurements, we will identify an optimal gel, from which we will monitor its syneresis (shrinkage). In addition, we will examine the effects of different groundwater compositions, including the presence of organic matter, heavy metals, salts, and nutrients, as well as variations in pH and temperature. With these data, we can predict the durability and feasibility of this technique for specific water and soil conditions.

In summary, your tasks will include: Receiving sufficient training, Conducting experiments, Preparing presentations, and Discussing results in our project meeting. You are not required to write a report; interpreting and presenting the outcomes is what we need.

Job requirements

Basic lab experience, and willingness to learn new skills.