
Pre-study and Master's project
Fall Semester 2023

Adsorption mechanisms in clays: An experimental and geochemical analysis

Supervisor: Professor Lyesse Laloui

Assistant: Svetlana Babiy

Motivation of the project

The aim of the project is to investigate the water adsorbed by clays (montmorillonite). The experiments will provide information about the amount of water attracted to clay particles depending on the concentration of saline solution (NaCl), the literature review in chemical field will provide the explanation of possible mechanisms.

Keywords

Experimental work, water adsorption, clays, swelling, water-clay interaction, effective solute suction, WP4C, total suction

References

1. Lambe, T. W., Robert V. Whitman, and T. William Lambe. Soil Mechanics, SI Version. Series in Soil Engineering. New York: Wiley, 1979. – **pages 40-58 (sections 5.1-5.4)**
2. Tester, Chantel C., Shaul Aloni, Benjamin Gilbert, and Jillian F. Banfield. 'Short- and Long-Range Attractive Forces That Influence the Structure of Montmorillonite Osmotic Hydrates'. Langmuir 32, no. 46 (22 November 2016): 12039–46. <https://doi.org/10.1021/acs.langmuir.6b03265>.

The framework that is going to be used for back-calculation of adsorbed water:

3. Tuttolomondo, Angelica, Alessio Ferrari, and Lyesse Laloui. 'Generalized Effective Stress Concept for Saturated Active Clays'. Canadian Geotechnical Journal 58, no. 11 (November 2021): 1627–39. <https://doi.org/10.1139/cgj-2020-0390>.

Goal of the project

By the end of the semester you will:

- learn the mechanisms of clay behavior;
- make contribution to the advanced topic of chemo-hydro-mechanical modelling;
- get acquainted with the laboratory equipment (hydraulic pump, interface, WP4C, Microcell);
- be able to work in an interdisciplinary field;

Tasks and work to carry out

1. Preparation of specimens (sieving the powder and then mixing it with a specific grain size distribution);
2. Preparation of solutions of NaCl (0.1M, 0.2M, 0.3M, 0.5M, 1M);
3. Assembling the setup, making measurements on WP4C device;
4. Determining the amount of water adsorbed by clay particles depending on the concentration (from literature) and comparing it with obtained results experimentally;
5. Analysis of the data obtained

Deliverables

- **Report**

The student will have to prepare a technical report containing the introduction and motivation for the project, the description of the accomplished work and related results as well as conclusions. The technical report will have to be prepared in an electronic format and send to the supervisor and the responsible of the project by the end of the semester.

- **Final Presentation**

The student will have to present his work during a presentation at the end of the semester. The day and the place of the presentation will be communicated to the student.

Planning

- **Meetings and presentations**

A weekly meeting (on Friday pm) with the assistant is suggested to discuss the progress of the project. One meeting per month will be organized with Prof. Laloui (dates will be communicated to the student). During the meetings with the assistant, the student will have to present (i) the progress of the work, (ii) possible questions and remarks and (iii) a summary of the next steps for the project. During these meetings, the supervisors may vary the foreseen goals of the project, if necessary. The student will have to prepare all the possible questions before the meeting in written form and a summary of each meeting for the next fixed meeting.

- **Report**

The report will be written in English. Graphs will be built with the aid of Microsoft Excel. Particular attention will be given to the writing up of the report. Literature review on water adsorption from the field of chemistry takes a major part of the work. Interest in chemistry is necessary. In the document, the student will have to clearly introduce the topic, to highlight the hypotheses made, to present the considered methodology, to discuss the obtained results and to draw the related conclusions.

- **Electronic files**

At the end of the project, the student will have to send to the supervisors a folder containing a clear classification of all the electronic files developed during the project, including those related to the reports, obtained data, presentations, poster and graphs.

Grading

The final grade will be assigned considering the following proportions of contribution:

- Implication and initiative during the semester 30%
- Technical report 50%
- Oral presentation 20%

General rules of the project

The schedule of the project is defined by the EPFL Academic Calendar:

<https://memento.epfl.ch/academic-calendar/?period=180>

The student signature on the submitted report certifies that the work is original and developed by him/herself. This work is property of the EPFL and cannot be disseminated without the approval of the considered Institution.

Contacts

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