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CS-C experiment
Experimental assessment of shale properties for safe geological CO_2 storage

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Introduction

Research of the chair "Gaz Naturel" – Petrosvibri at the EPFL contributes to the CS-C experiment in the underground rock laboratory in Mont Terri. The research focuses on the assessment of shale properties for safe geological storage of CO_2.

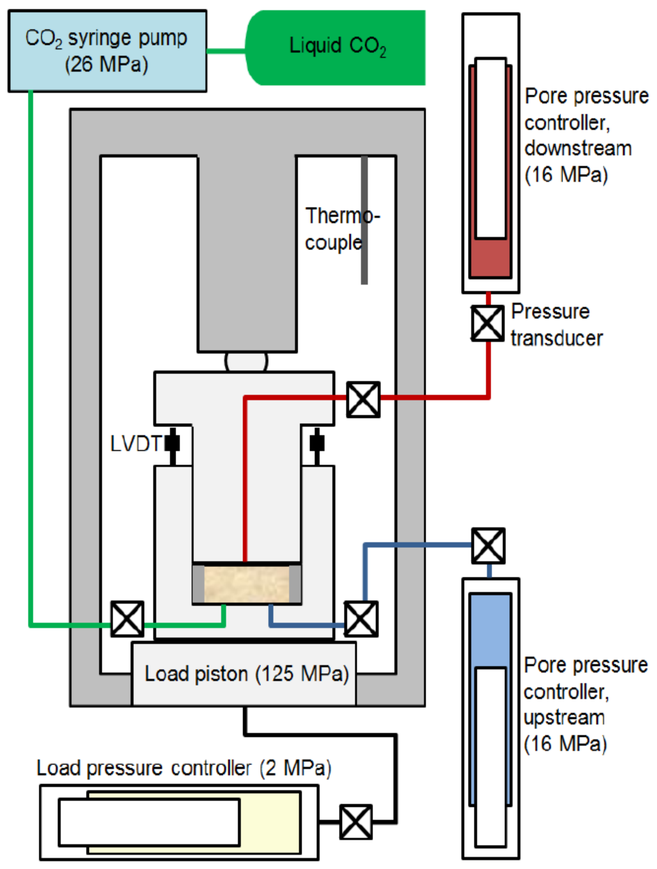
Proper assessment of carbon dioxide storage procedures allows for a significant reduction of its concentration in the atmosphere and thus directly contributes to Swiss energy strategy 2050. The sound characterization of reservoirs and caprocks in Switzerland and the assessment of their potential for CO_2 storage is therefore fundamental.

In order to grant a safe injection of CO_2 into reservoir formations, the overlaying shaly caprock must perform efficiently. This work aims at identifying the relevant processes related to shale-CO_2 interactions and the impact of CO_2 injection on the mechanical properties of the material.

Experimental methodology

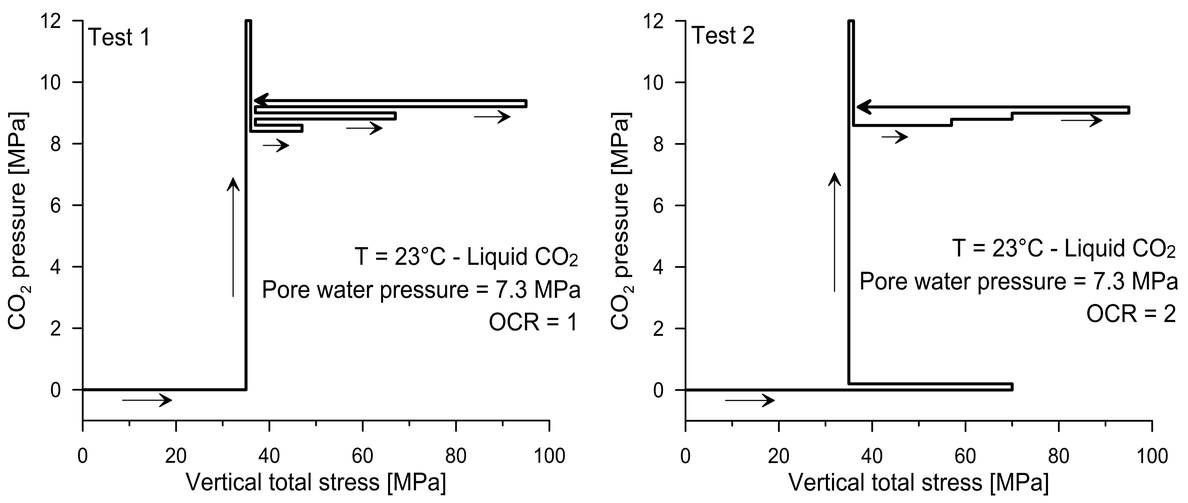
Cylindrical specimens of intact Opalinus Clay shale :
- height = 12.5 mm
- diameter = 35 mm

An advanced oedometric cell (imposing zero lateral strain) is used.



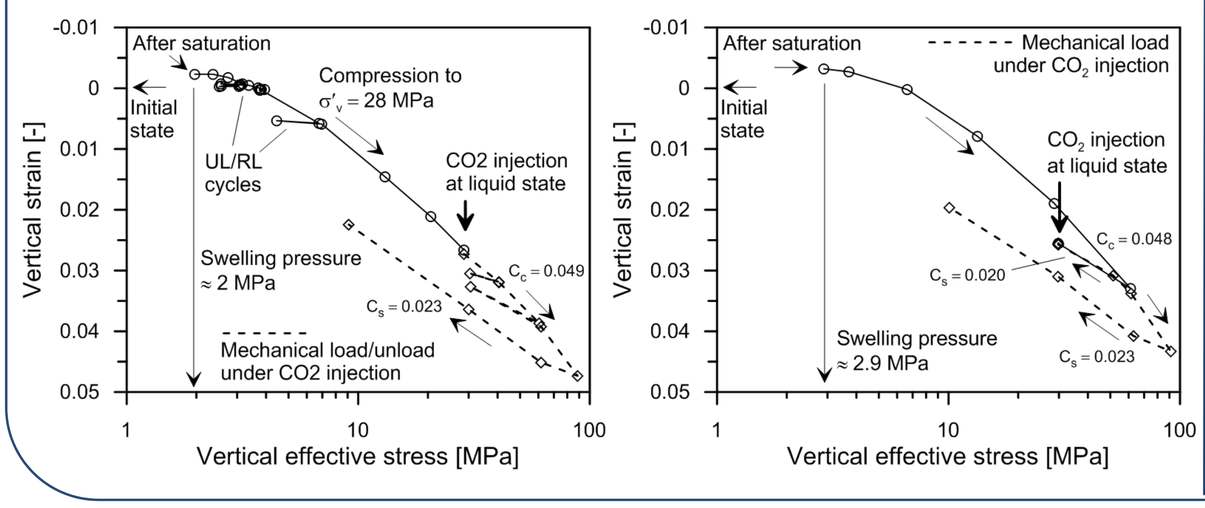
Procedure for Test 1 and Test 2:
- Saturation in constant volume conditions;
- Pore water pressure increase to 7.3 MPa while maintaining constant vertical effective stress;
- Consolidation in steps to the desired stress state;
- CO_2 injection at liquid state (23°C, pressure up to 12 MPa)
- Mechanical compression up to 90 MPa of vertical total stress.

The stress paths of the tests are depicted below:



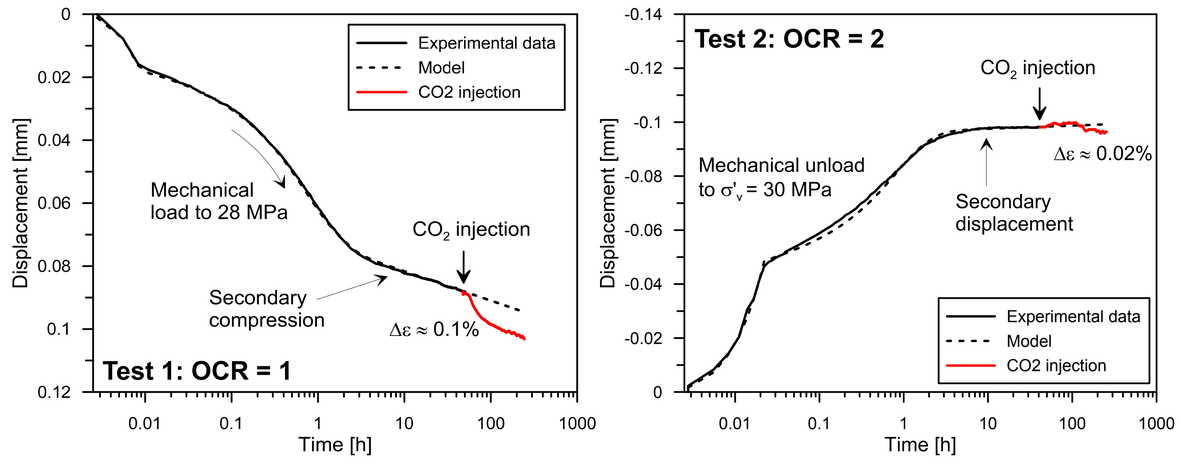
Results

Vertical strain versus vertical effective stress during oedometric loading and during CO_2 injection at constant vertical effective stress.



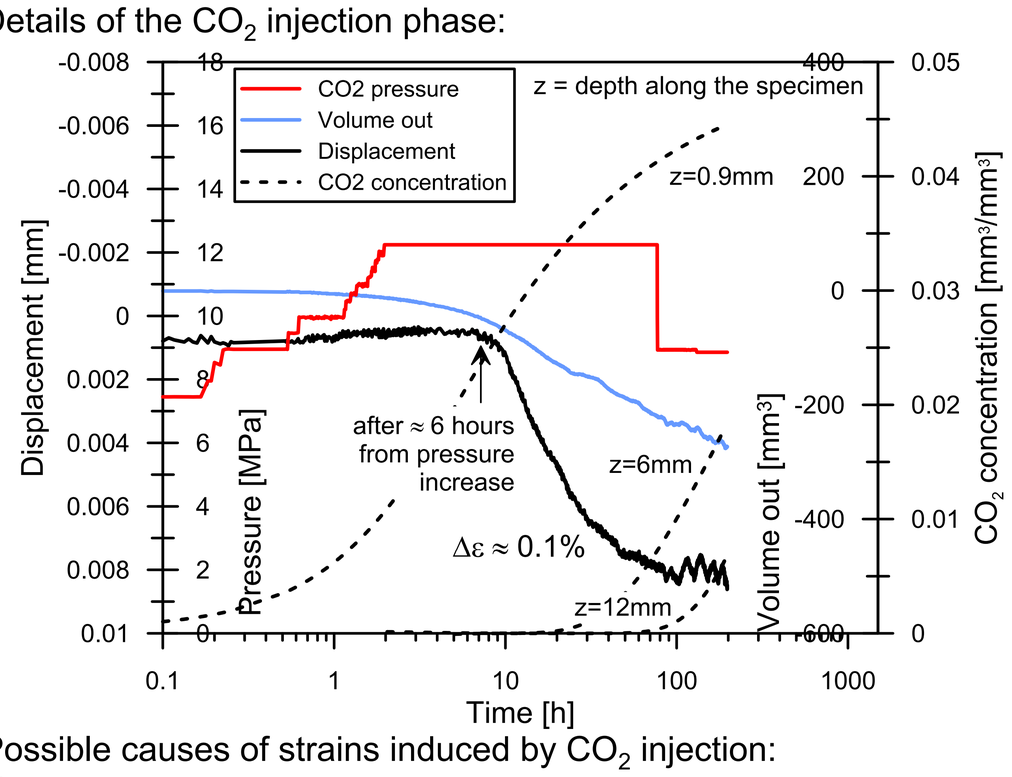
Results and Discussion

Loading (test 1) and unloading (test 2) steps prior to CO_2 injection (black solid line), followed by the CO_2 injection phase (red line)

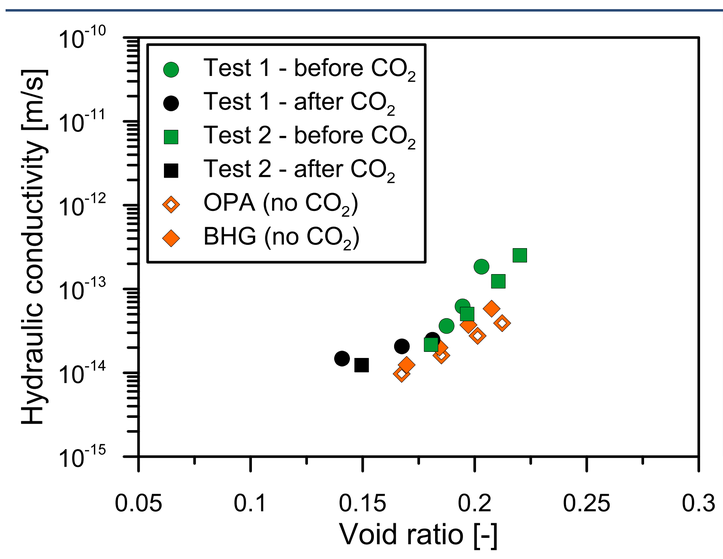


Strain induced by CO_2 injection is relevant at OCR = 1
→ material is more prone to compact when it is found in normally consolidated conditions

Details of the CO_2 injection phase:

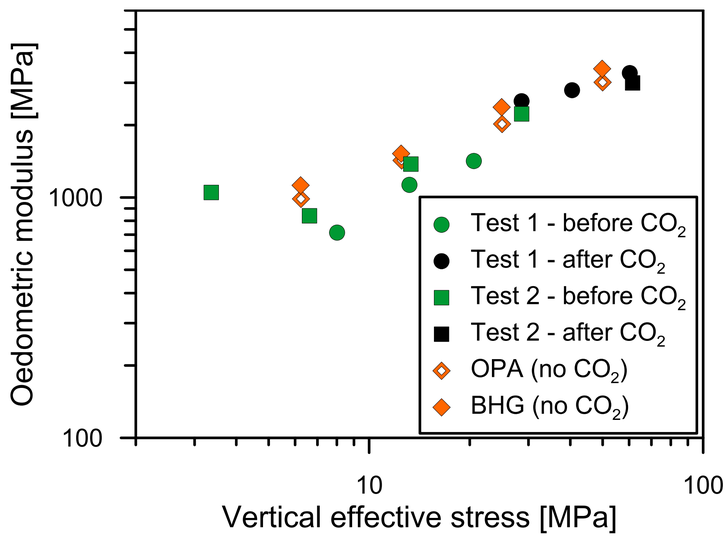


Possible causes of strains induced by CO_2 injection:
→ Desaturation effects (CO_2 / pore water differential pressure)
→ Double layer effects induced by the diffusion of CO_2



The impact of CO_2 injection on the deformation behaviour of the material appears to be limited compared to the deformation behaviour induced by a mechanical loading.

Diffusion of CO_2 into the shale does not impact significantly the hydro-mechanical properties of the material, since no significant change in oedometric modulus and hydraulic conductivity are highlighted after the injection of CO_2.



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