
# Triaxial testing and geophysical monitoring of reservoir and cap rock samples from UNIS CO2 LAB pilot, Longyearbyen Svalbard, Norway

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## Introduction

This study examines different geophysical methods for monitoring $CO_2$ flow and acoustic emission of the reservoir (storage unit) and cap rock samples that were acquired during the pilot project at UNIS CO2 LAB, Longyearbyen. The objective of the UNIS CO2 LAB pilot project was to evaluate feasibility of the sandstone in the Upper Triassic to Middle Jurassic Kapp Toscana Group De Geerdalen as a storage unit and the overlying near 400 m thick Middle Jurassic to Lower Cretaceous shale-dominated Agardhfjellet and Rurikfjellet formations as cap rock for $CO_2$ storage reservoir. The penetrated reservoir unit from 672 to 970m below surface is a low permeability moderate porosity fractured sandstone unit (i.e. an unconventional reservoir). The 200m overburden consist of Lower Cretaceous heterolithic sandstone and shale.

## Methods

Two core samples from the reservoir and cap rock was analysed. The first sample to test the reservoir sandstone was from the Kapp Toscana Group, well Dh2 at depth of 772 m was used for a CO2 flow test. The sample contained a pre-existing fracture along its axis (Figure 1). Brine and liquid-phase CO2 were injected into the sample in a triaxial set-up and acoustic velocity and resistivity were measured in both axial and radial directions. The second sample was a dark shale from one of the cap rock units in Dh6 at depth of 299 m, Rurikfjellet Formation selected for acoustic emission (AE) test. It was first loaded isotropically up to 6 MPa. Then, the differential stress was increased until the sample failed, while the confining stress was kept constant.

## Results and Discussion

Results of the $CO_2$ flow test showed that P-wave velocity decreased very slightly when $CO_2$ was injected into the sample. Velocity drop for the axial P-wave was more than the radial ones. A slight drop was also observed for the S-velocity. Resistivity increased when $CO_2$ injection started. The increase in resistance varied for different sensors but was generally about 5 to 10%. From the AE test, very few, i.e. a total number of 20, acoustic emission events were observed, mainly at peak stress and after failure

(Figure 1). Velocity data, acquired during AE test, were also used for event location. All events occurred in the middle of the sample with very small magnitude, ranging from -3.6 to -2.8.

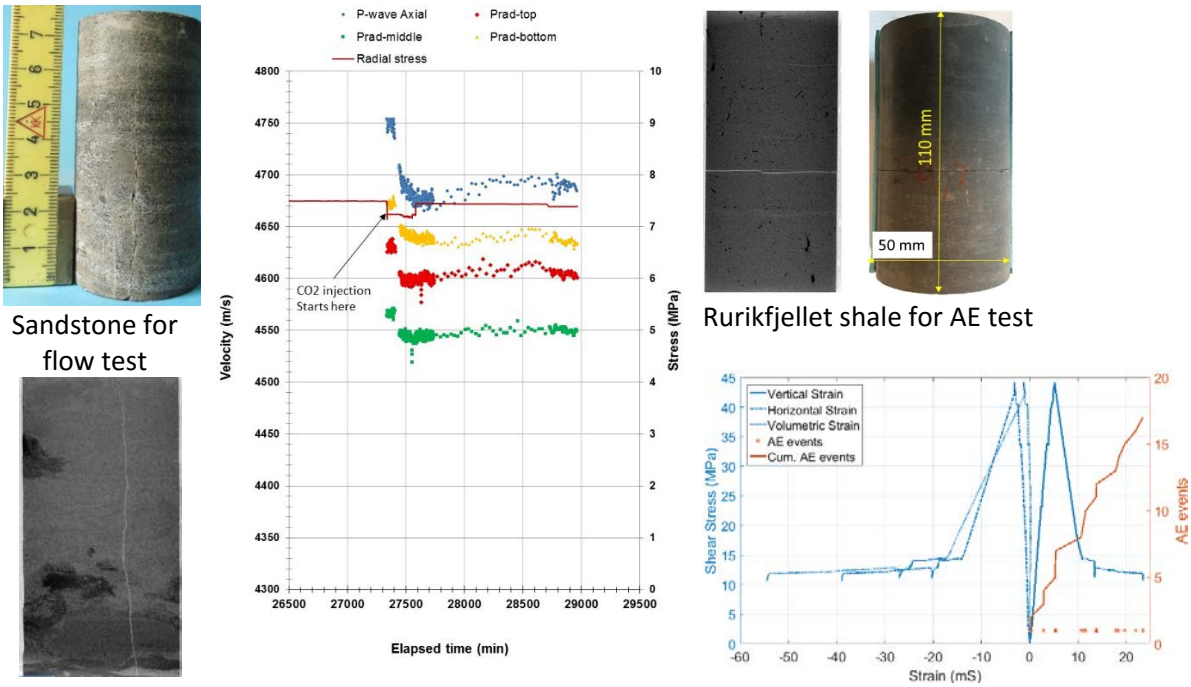


*Figure 1: Photo and CT scan of sandstone sample from Dh2, depth 772.37 m, used for $CO_2$ flow test (left), Change in velocity upon $CO_2$ injection (middle), Shale sample used for Acoustic emission test and the results (right).*

The laboratory observations of changes in resistance and velocity reported here can give a qualitative indication of the expected changes during injection of $CO_2$ at field scale in the Longyearbyen (or similar) fractured sandstone reservoirs. Acoustic emission test, however, suggests the tested shale may produce very small emission events in terms of both number and magnitude of events, even during the failure of intact rock. This observation implies that detecting potential failure of sealing shale units may be challenging also in field scale microseismic monitoring campaigns. In summary, changes in velocity and resistivity have been observed after starting injection of liquid $CO_2$, and we are able to detect changes in fluid with geophysical methods in this sandstone under laboratory conditions. The acoustic emission test showed the capacity of the set-up to detect and measure emissions as small as about -4 in magnitude.

**Acknowledgement**

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