The Longyearbyen CO₂ lab, Adventalen, Svalbard - a test site for storage, flow and leakage of fluids in an unconventional reservoir.

Snorre Olaussen¹, Alvar Braathen¹,³, Kei Ogata¹, Kim Senger¹,²,³ and Jan Tveranger²

¹Department of Arctic Geology, University Centre on Svalbard (UNIS Svalbard, Norway
²Uni CIPR, Uni Research, Bergen, Norway
³Department of Earth Science, University of Bergen, Norway

The vision of the Longyearbyen CO₂ laboratory (LYB CO₂ Lab) is threefold; 1) Use the favorable conditions in Longyearbyen to develop and/or test technologies for carbon capture and storage, 2) turn Longyearbyen into a high-profile showcase as a community that takes care of its CO₂ from the source to solution][sequestration, and 3) build high level university courses along the entire CO₂ value chain. To entertain the vision, 6 wells have been drilled and subsequently tested for injectivity and fracturing pressure during test campaigns in the summers of 2010 and 2011. For the tests, the sites were equipped with commercial pumps and containers normally used for fracturing unconventional reservoirs in tight oil and gas fields or shale gas. This underlines the Longyearbyen CO₂ laboratory as a test site for storage, flow and leakage of fluids in an unconventional reservoir.

The reservoir of the potential storage unit is a 300m thick heterolithic sandstone/shale unit, situated in the Upper Triassic to Middle Jurassic Kapp Toscana Group. In the Adventalen, well DH 4 penetrated and cored 300m of the Group with a TD at 970m and the top reservoir at 670m below surface (656 msl). During the summer season of 2010 the well was tested for fluid flow an open well in the lower 100m of the group. Despite the low net gross and tight reservoir unit at this level {N/G 0.2 - Permeability less than 1mD a – porosity at the best 7% }, the reservoir revealed a total flow capacity of approximately 45 m³/m, thus verifying the water transmissibility of the reservoir. The observed injectivity of the otherwise tight reservoir is governed by the presence of fractures, some of them open, observed throughout the reservoir unit both in well cores, by televiewer scanning and in outcrops.

Under pressure of about 50 bars relative to hydrostatic pressure was observed at reservoir level. The precise cause for this is unclear but clearly related to uplift (+3km) and compartmentalization within an open, gentle monocline. Under pressure of up to 20 bar is also known from exploration wells in the Barents Sea.

The reservoir is capped by the 400m thick Middle Jurassic to Lower Cretaceous shale unit, potentially acting as a seal/cap rock for a CO₂ accumulation. Above the shale unit a Lower Cretaceous deltaic unit is an aquifer with a slight overpressure. Two shallow wells were drilled during the summer of 2011 and tested for fluid flow and hydraulic yield strength. Although there is low permeability and moderate porosity (10 -12%) of the over-pressured lower Cretaceous deltaic unit, 120 l/min of brine was flowing from a controlled “blow out”. This unit would be an excellent observatory level for tracking possible leakage from the underlying aquifer in the Kapp Toscana Group. During the operation in 2011, two rock mechanic tests in the cap rock were also successfully performed.

One of the major challenges of the test site is geophysical and geological monitoring of fluid flow, pressure change and fracturing, and in the future leakage and saturation of different fluids. At the moment, 10 geophones are emplaced around the drill site. So far the recorded signal is inconclusive.

The advancement of Longyearbyen CO₂ laboratory is the low cost operations for testing rock units, local operational staff, and active involvement from sponsors and operational companies. Further, national and international research cooperation broadens the scientific inputs. The possibility to study the reservoir and cap rock strata in outcrops and in drill core strengthens the study.