The Pre-ACT project

- Pressure control and conformance management for safe and efficient CO_2 storage

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https://www.sintef.no/pre-act

Introduction

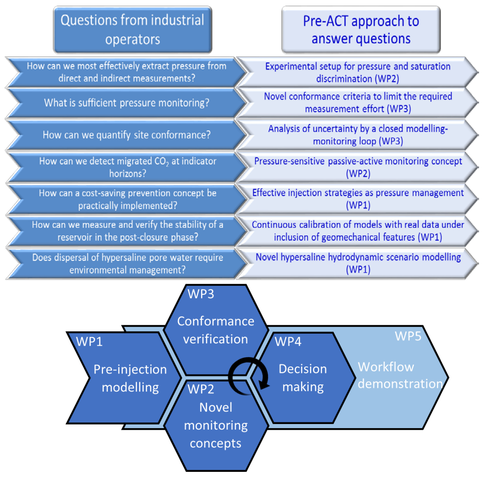
- Pre-ACT is a large research project focusing on "Pressure control and conformance management for safe and efficient CO_2 storage – to Accelerate CCS Technologies"
- The development of improved strategies for monitoring and management of the pore pressure distribution within the storage reservoir targets crucial storage challenges as capacity, confidence, and cost
- A partnership of 6 research institutes and 4 industrial partners secures cutting-edge research of the highest industrial relevance

The objective of Pre-ACT is to equip operators and regulators with **pressure-driven decision support protocols (Pre-ACT Protocols)** that enable them to establish a safe and efficient monitoring system and to assess quantitatively site conformance.

Budget: ~ 5.2 MEuro
Duration: 1/9 2017 – 31/8 2020
Partners: SINTEF (coordinator), BGS, GFZ, TNO, NORSAR, PML
Industry: Shell, Equinor, TAQA, Total

The Pre-ACT approach

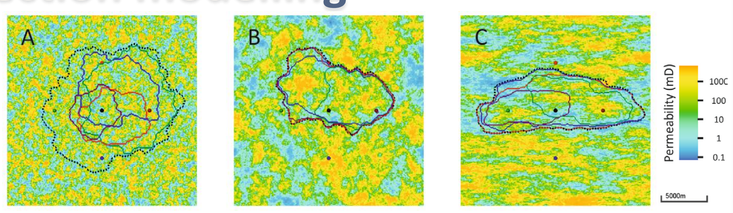
- Answering to industry needs (questions from industrial operators)
- Learning from demonstration, pilot, and field lab data (including new data from Svelvik CO_2 Field Lab)
- Deliverables with focus on industry uptake (e.g. workshops, some of which are public)



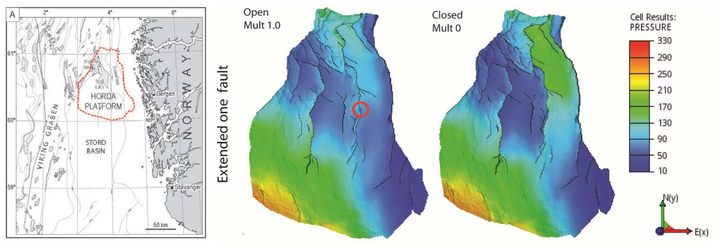
Pre-ACT approach: *(top) Examples of questions from industrial operators and how those are answered. (bottom) Pre-ACT work packages reflecting a suggested conformance verification workflow based on monitoring of pore pressure distribution.*

WP1: Pre-injection modelling

- Study optimal injection planning via effective pressure control
- Focus on understanding propagation and control of pressure increases following injection through a program of modelling and laboratory work



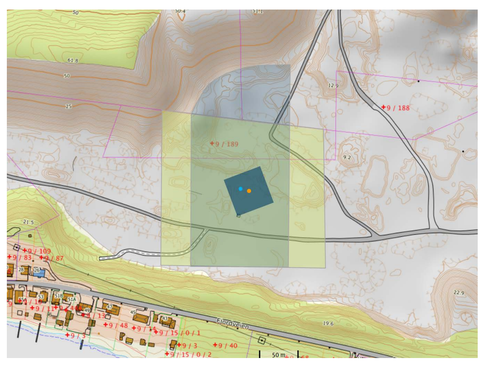
Effect of geological heterogeneity: *5-bar pressure increase contour for four different production well locations (around a central injection well, 1 MT/y). Dashed lines correspond to no water production, while red, brown, blue, and green indicate the 5-bar pressure increase contour with water production from each of the corresponding production wells 5 km from the injection well.*

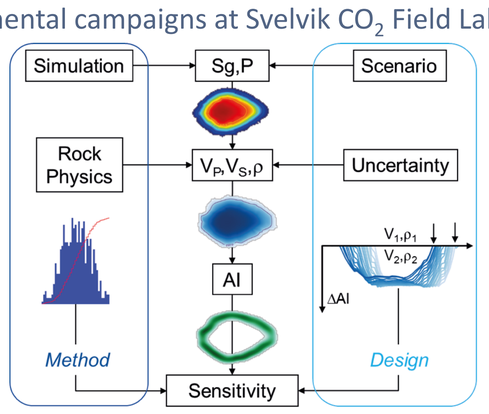


Effect of uncertain fault characterisation Horda Platform: *Simulated water-fluid pore-pressure after 27 years of O&G production from Troll (1995-2022), and thereafter 50 years of CO_2 injection, and continued O&G production. Maps show modelled pressure in year 2072 with one extended fault in the relay zone along the Vette Fault (red circle), varying the sealing properties of the fault from open to sealing (mult 1.0). Adapted from Lothe et al. (2018).*

WP2: Novel monitoring concepts

- Minimize cost by using passive-active monitoring strategy
- Establish novel concepts for quantitative monitoring and discrimination of pressure and saturation changes
- Provide input (including uncertainty) for real-time conformance verification
- Developments supported by experimental campaigns at Svelvik CO_2 Field Lab

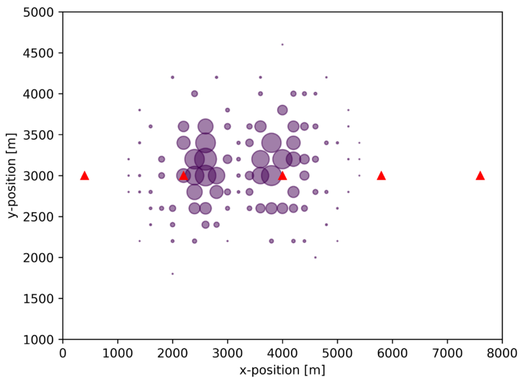


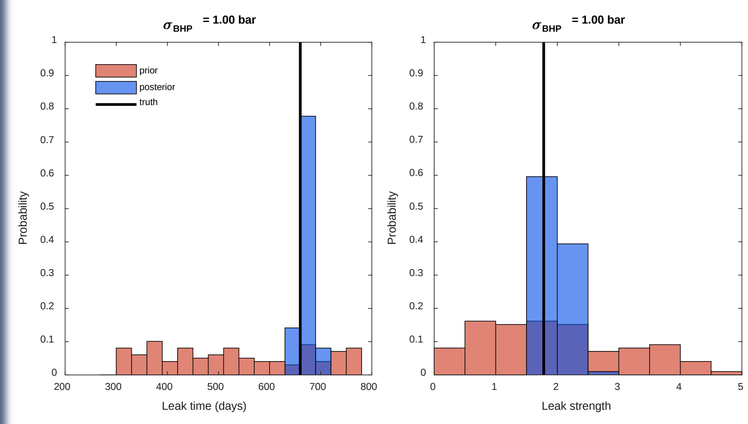


Experimental work and method development for pressure-saturation discrimination: *[left] Schematic of borehole setup at Svelvik CO_2 Field Lab. Blue square outlines the area of a new migration experiment (with new wells at each corner). The blue and yellow dots denote the existing wells Svelvik#1 and Svelvik#2 respectively. Svelvik#2 is designated for CO_2 injection at about 65 m depth, see Ringstad et al. (2018). [right] Components of the acoustic impedance sensitivity analysis for the Svelvik experiment, taken from Weinzierl et al. (2018).*

WP3: Conformance verification

- Develop and evaluate approaches (based on quantitative criteria) for verification of site conformance.
- Establish detection limits and find measure of conformance to evaluate consistency between monitoring data and modelled CO_2 behaviour.





Value-of-Information for monitoring of conformance: *[top] Optimal lateral source positions for CSEM inversion denoted by purple circles, the area of a circle being proportional to its sensitivity to subsurface conductivity changes. Red triangles represent fixed lateral receiver positions. From Romdhane and Eliasson (2018). [left] Distributions of leak properties. Histogram of leak onset time and leak strength for prior (red) and posterior ensembles (blue) obtained through history matching; the true value is indicated by a black line. Adapted from Barros et al. (2018).*

WP4: Decision making (only initial workshop so far)

- Investigate options for an operator if a pressure-based conformance test fails
- Select the optimal response to non-conformance
- Study how to control CO_2-induced pressure increase to avoid leakage and costly remediation

WP5: Workflow demonstration (not started)

- Demonstrate developed methodology for storage scenarios at realistic sites (Smeaheia, P18-4, Q16-Maas, UK case)
- Communicate results to authorities, regulators, policy and decision makers, …

Concluding remarks

- Most work during first year in Pre-ACT has addressed pre-injection (pressure) modelling, pressure and saturation monitoring, and conformance assessment
- During second year, modelling and feasibility studies will be complemented with lab and field lab experiments
- WP4 and WP5 work will gain momentum during second and third year

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