



15th International Conference on Greenhouse Gas Control Technologies GHGT-15

5th -8th October 2020, Abu Dhabi, UAE

Assuring integrity of CO₂ storage sites through ground surface monitoring (SENSE)

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Abstract

Monitoring of geological CO₂ storage is crucial for large-scale injection to gain acceptance as a reliable method for globally reducing CO₂ emissions. Monitoring plans for large-scale operations need to include both the injection and post-injection phases to assure CO₂ is safely stored over geological time-scales. The SENSE project aims to develop reliable, continuous, and cost-efficient monitoring based on ground movement detection combined with geomechanical modeling and inversion, utilizing new technology developments, data processing optimization, and interpretation algorithms. The proposed research activities include:

- demonstration of continuous monitoring of surface deformation and subsurface pressure distribution using satellite data, water pressure sensors, tiltmeter array, fiber optics, and seafloor geodesy;
- quantitative characterization of critical geomechanical and hydraulic parameters and automatization routine for data processing and interpretation;
- optimization of sampling arrays in order to offer storage site operators a cost-effective monitoring option as part of an effective site assurance programme, and feeding into existing workflows for an early alert system.

SENSE project brings experts from 14 international institutions and eight different countries together to solve challenges in CO₂ storage site monitoring and provide solutions for safe and successful injection during injection and post-closure phases of site operation. The project is organised in five Work Packages (WPs); WP1: Quantification of

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ground movement, WP2: Geomechanical modelling and rock strain assessment, WP3: History matching inversion and coupled flow-mechanics, WP4: Integration of results for cost-effective monitoring and WP5: Project management. The ultimate goal of SENSE is to offer storage site operators a cost-effective monitoring option that can form part of an effective site assurance/monitoring programme and feed into workflows for an early alert system to detect unexpected changes in the subsurface.

The SENSE project has four candidate sites for demonstration of monitoring technologies and developing concepts and procedures for efficient, cost-effective storage site monitoring. These sites are both onshore and offshore. The onshore sites include Hontomin-Spain/In Salah-Algeria and a natural gas storage in the UK. For onshore sites, the project will use satellite data and ground surveying to explore the response of the surface to pressure changes in the subsurface. Algorithms for automatic satellite data processing to facilitate quick access to ground elevation data for site operators will be developed. The offshore sites include Bay of Mecklenburg-Germany, Gulf of Mexico, and possibly Troll Gas Field, Norway. State-of-the-art techniques will also be applied for seafloor level monitoring including bathymetry, pressure sensors and fibre optic monitoring on the sea bottom.

SENSE is well underway. The first field campaign at Bay of Mecklenburg-offshore Germany was completed in late 2019. It provided both gravity cores from the seabed and geophysical data acquisition for characterisation of subsurface layers. Analysis of geophysical data and testing of cores will be carried out in February - May 2020 and will provide input parameters for the design of gas injection in shallow layers underneath the seafloor to examine the pressure footprint. The first results of the site characterisation will be presented at GHGT-15, along with the plans for the offshore and onshore candidate sites.

Keywords: CO2 storage monitoring, Fibre optics, Geomechanics, Injection, InSAR, Offshore monitoring, Pressure, Seafloor deformation, SENSE-ACT, Uplift.

Monitoring CO2 storage sites

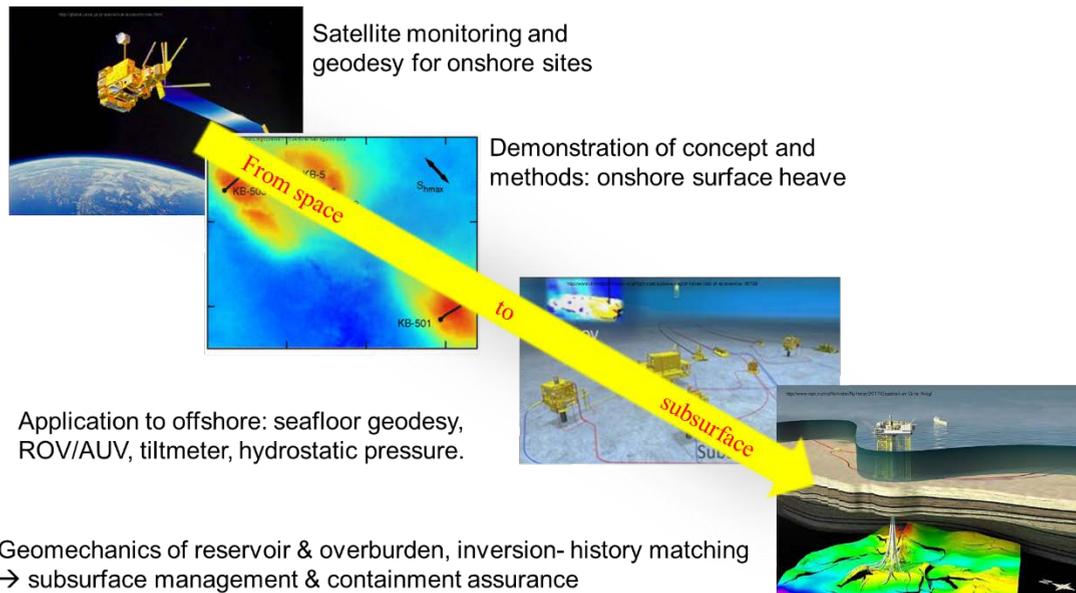


Figure 1 presents the concept of SENSE project, illustrating the range of monitoring tools and techniques to be used.