Understanding the Geophysical Response of Carbon Sequestration Sites to CO2 Injection

Supervisors

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Project description

Carbon capture and storage (CCS) projects, where CO_2 is injected into the ground to be stored at depth, is one technology with the potential to reduce anthropogenic CO_2 emissions to mitigate global warming. For the technology to be safe and effective, this CO_2 must remain trapped for thousands of years. Geophysical monitoring techniques play an important role in characterising CCS sites and understanding the migration of CO_2 once it has been injected.

These geophysical methods include passive seismic monitoring (PSM) and 3D seismic surveys. PSM deployments use surface or borehole geophones or broadband surface instruments to record any seismic activity at or surrounding the site. The location of this seismicity highlights any activated faults or fractures that potentially indicate migration pathways for CO_2. Time-lapse seismic surveys are used to track CO_2 migration and verify the site provides secure storage (Figure 1).

This project will consist of technique development in both these areas of geophysical monitoring using data from two Canadian projects. The first is the Aquistore site, the world's first commercial CCS project attached to a coal-fired power station. PSM data recorded at the site will be analysed to improve seismic event detection techniques and a detailed treatment of the data will investigate geophysical properties such as seismic anisotropy (the variation of seismic wavespeed with direction of propagation) to aid understanding of the site response to CO_2 injection.

The second dataset comprises of PSM and 3D seismic data from the Field Research Station (FRS), a site being developed for CCS research in affiliation with the University of Calgary. In addition to the analysis of seismic events, ambient noise interferometry will be used to map underground structures in the area and understand the migration of CO_2 at shallow depths. The 3D seismic data will be used to test and validate time-lapse tools to identify the extent of injected CO_2.

This project will involve seismic data analysis from industrial and research sites and computer programming. It therefore requires a numerate student with a degree in physics, geophysics or a related subject. The student will develop skills and techniques applicable to many areas of geophysics, relevant for both further academic study and industrial employment. There may also be the opportunity to deploy and service seismic instruments.

References:

Stork, A.L., Verdon, J.P., Kendall, J.-M., 2015. Assessing the microseismic response at the In Salah Carbon Capture and Storage (CCS) site with a single three- component geophone. Int. J. Greenh. Gas Control 32, 159–171.

Verdon, J.P., Kendall, J.-M., Stork, A.L., Chadwick, R.A., White, D.J., Bissell, R.C., 2013. Comparison of geomechanical deformation induced by megatonne-scale CO2 storage at Sleipner. Weyburn, and In Salah. PNAS 110, E2762–E2771.

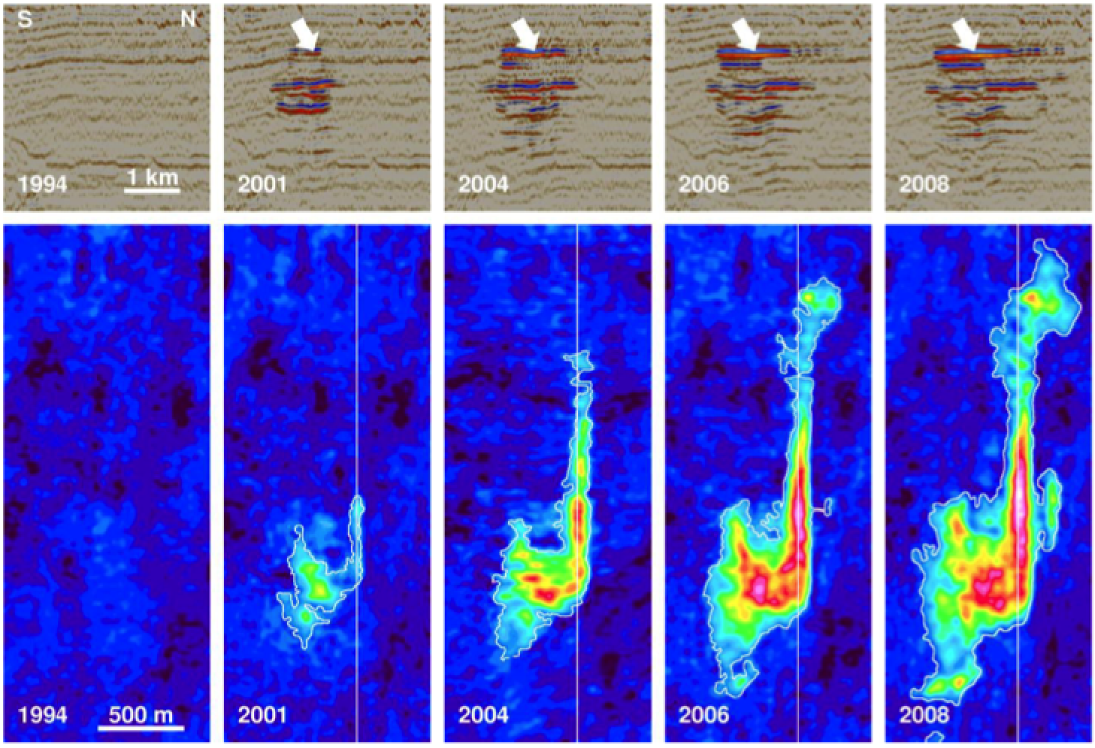

Figure 1: A cross section from successive time- lapse seismic surveys at Sleipner (upper panel) and the total reflection amplitude of the expanding topmost layer in plan view (lower panel).