Verifying safe CO_2 storage with VSP surveys at Aquistore, Saskatchewan, Canada

CARBON CAPTURE AND STORAGE RESERVOIR MONITORING

CASE STUDY

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Aquistore, Saskatchewan, Canada

Project background

Aquistore, the world's first combined commercial power plant and carbon capture and storage (CCS) project, is located in Estevan, Saskatchewan, Canada. It is managed by the Petroleum Technology Research Centre (PTRC).

CO_2 is captured at the nearby SaskPower Boundary Dam coal-fired power plant. Following capture, a portion of the CO_2 is sold for enhanced-oil-recovery (EOR) operations and the remainder is transported by pipeline to the Aquistore site approximately 5km away.

The CO_2 is injected into a deep reservoir via a 3,000 m injection well, where more than 275,000 tonnes of CO_2 has been permanently stored since April 2015.

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The Monitoring Challenge

Any CCS project requires a comprehensive monitoring, measuring and verification (MMV) plan to ensure safe storage of the CO_2. Conventional active seismic methods provide snapshots of the site over time but are expensive.

One safety concern and monitoring challenge is verifying that the CO_2 does not leak into the geological layers above the storage reservoir with the use of seismic imaging methods. Any leakage negates the positive impact of mitigating climate change effects by preventing emission of the CO_2 to the atmosphere.

Another challenge is passive monitoring for any seismic events induced by the volume of CO_2 injected. These seismic events may indicate CO_2 leakage pathways or, if large enough, may damage infrastructure. An important part of MMV implementation is active seismic surveys to monitor and verify the behaviour of the CO_2 underground and track the extent of the CO_2 plume.

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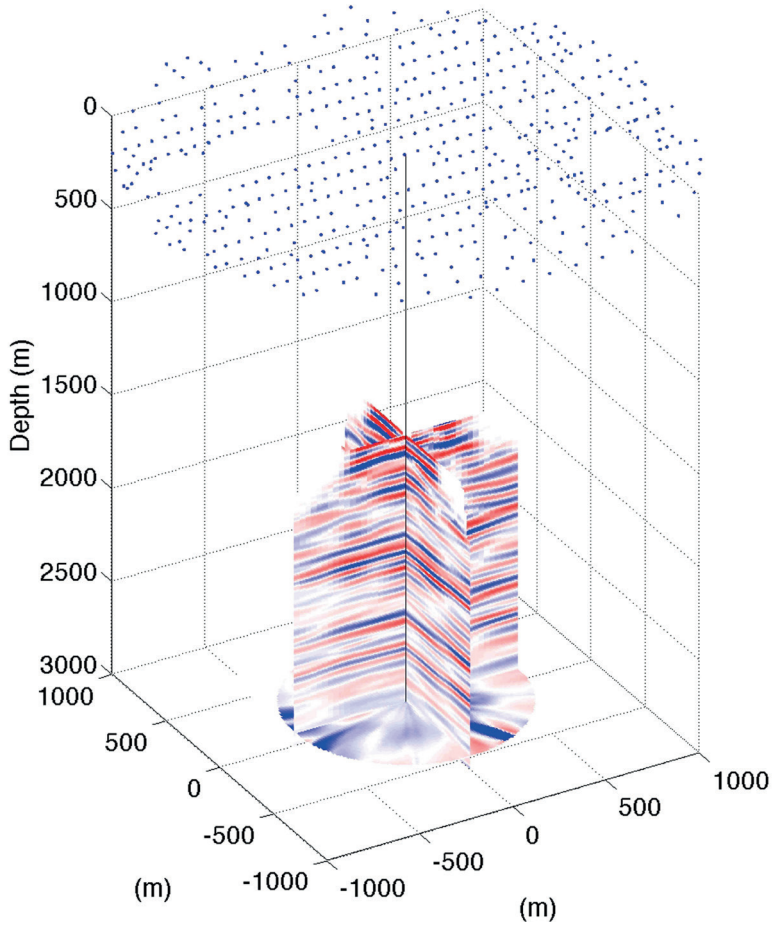
The Solution

Distributed sensing offers a viable alternative to geophone arrays for the acquisition of seismic data. It reduces monitoring costs and provides spatially and temporally continuous data.

A fibre-optic cable is permanently deployed in a monitoring well at the Aquistore site. This supplies a long-term and on-demand monitoring solution.

The benefits and quality of fibre-optic Distributed Acoustic Sensor (DAS) are proven for seismic acquisition, particularly for Vertical Seismic Profile (VSP) surveys. DAS provides the capability to conduct repeat (4D) surveys without intervention in the monitoring well, hence providing a cost-effective solution.

The data obtained from DAS are well suited to facilitating the detection of changes in seismic response due to the presence of CO_2. The fibre can also be used to detect any seismic events at the site.



High-resolution 3D VSP image produced from iDAS™ seismic data.

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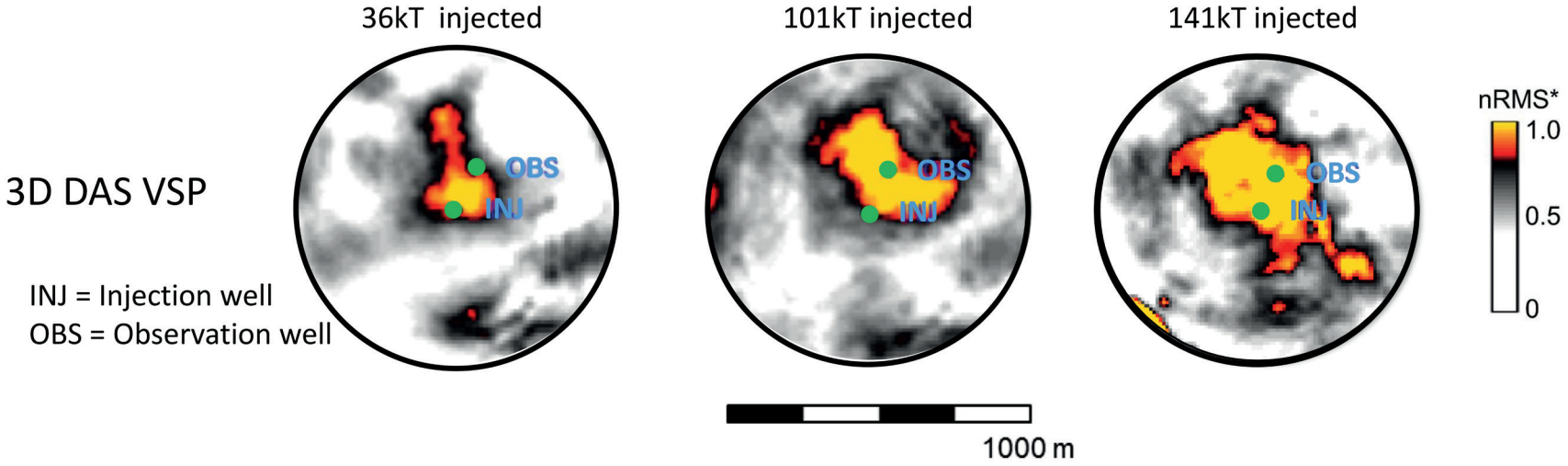
Results

With minimal environmental impact, Silixa's iDAS™ provides a long-term, on-demand and cost-effective seismic monitoring solution for safe CO_2 storage at Aquistore and for CCS in general.

iDAS units have been used at Aquistore since 2013 to provide baseline and monitoring data via VSP surveys, with the most recent being in January 2020. These data have been used to image the CO_2 storage reservoir and track the extent of the CO_2 plume and verify caprock integrity. Significant leakage of CO_2 from the storage reservoir would be observable in the seismic response recorded by an iDAS interrogator.



Extent of CO_2 plume (bright colours) monitored over time with 3D VSP surveys recorded on a fibre-optic cable and Silixa iDAS unit. Monitoring surveys were conducted after 36kT, 102kT and 141kT of CO_2 were injected (courtesy of Don White, Geological Survey, Canada).

References

1. White, D., K. Harris, L.A.N. Roach & M. Robertson (2019). 7 years of 4D seismic monitoring at the Aquistore CO2 storage site, Saskatchewan, Canada, SEG Extended Abstracts, 89th Annual Meeting, 4918 – 4922, doi: 10.1190/segam2019-3216776.1.

2. Harris, K., D. White, D. Melanson, C. Samson & T.M. Daley (2016). Feasibility of time-lapse VSP monitoring at the Aquistore CO2 storage site using a distributed sensing system, International Journal of Greenhouse Gas Control, 50, 248 – 260, doi: 10.1016/j.ijggc.2016.04.016

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