

## The Sleipner CO<sub>2</sub> 4D Story: 15 Years of CO<sub>2</sub> Storage and Seismic Monitoring

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### Summary

In 1996 Statoil and its partners began injecting approximately one million tonnes of CO<sub>2</sub> per year, into a sand rich, saline aquifer, that lies some 800-1100 m beneath sea surface at the Sleipner Øst Field, in the Norwegian North Sea. In order to ensure cap rock integrity and to evaluate subsurface CO<sub>2</sub> plume development, seven time-lapse (4D) seismic surveys have been acquired at regular intervals since the original pre-injection survey of 1994 vintage. These were collected in 1999, 2001, 2002, 2004, 2006, 2008 and 2010, and reveal in detail, the temporal development of the CO<sub>2</sub> plume as it has been migrating away from the injection well. The plume manifests itself very conspicuously on seismic data, due to the higher compressibility and lower density of the injected CO<sub>2</sub>, relative to the ambient, connate, pore filling waters. By 1999 some of the CO<sub>2</sub> had reached the top of the aquifer, and had also begun to spread out laterally, in thin layers beneath discontinuous intra-formational mudstone beds. By 2008, after 10.2 millions tonnes of CO<sub>2</sub> had been injected, there were no indications of leakage into the overburden, the plume had extended to a maximum of 2775 m away from the injection point, had a long axis of 4260 m, and had an areal coverage of 3.1 km<sup>2</sup>. The observed increase in integrated seismic amplitudes seen between surveys is consistent with the increase in CO<sub>2</sub> injected. Continued seismic monitoring of this industry leading project has given validity to the Carbon Capture and Storage (CCS) concept, which in turn has paved the way for new projects, and has helped to influence a more environmentally focused European energy policy.

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