

The Sleipner CO₂ 4D Story: 15 Years of CO₂ Storage and Seismic Monitoring

Chris R. Kennett*

Statoil ASA, Stavanger, Norway

chke@statoil.com

and

Ola Eiken*

Statoil ASA, Trondheim, Norway

oei@statoil.com

Summary

In 1996 Statoil and its partners began injecting approximately one million tonnes of CO₂ 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 CO₂ 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 CO₂ 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 CO₂, relative to the ambient, connate, pore filling waters. By 1999 some of the CO₂ 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 CO₂ 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 km². The observed increase in integrated seismic amplitudes seen between surveys is consistent with the increase in CO₂ 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.

Acknowledgments

We would like to acknowledge our colleagues in Statoil, particularly those in the research centre at Rotvoll, in Trondheim, Norway. We would also like to thank the license partners (ExxonMobil and Total) for continuing to allow us to release information on the CO₂ storage project at Sleipner.