



Feasibility study of time lapse seismic monitoring at planned CO₂ storage site

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Vattenfall is investigating the possibilities for onshore CO₂ storage in the northern part of Jutland, Denmark. The studies are related to plans for an early commercial CO₂ capture plant at the Nordjyllandværket Power Plant in 2020. A preliminary baseline monitoring plan is developed based on work done by CO₂GeoNet in 2009 which recommended the use of repeated 2D and 3D seismic surveys for future monitoring of CO₂ plume development. For an onshore site however, it is particularly necessary to verify the repeatability of 2D and 3D seismic surveying under moderate fold coverage because of possible influence on seismic response related to irregularities especially in the weathering layer. In this study the feasibility of seismic time lapse data for validation of CO₂ plume propagation is evaluated for the Vedsted Structure.

In August-October 2008 Vattenfall A/S acquired a 2D seismic survey with a semi-regional coverage focussing on the Triassic Gassum Sand Formation at approximately 2 km depths at the Vedsted Structure. Three representative lines from this survey have been selected for pre-evaluation of time lapse seismic survey monitoring as a tool for validation of CO₂ propagation during/after time of CO₂ injection. The data are used for the test by separation into two separate parts before stack and assessing the differences between them after stack. The input data used are pre-processed CDP gathers (after F-K DMO).

The input data separation used in the analyses is directly related to the setup used in the acquisition of the data, i.e. input from every second shot-point are selected pre-stack (unequal/equal FFID shot-points). The selected data are stacked and the relative energy of the difference between stack of data containing equal/unequal shot-points compared to the stacking-energy using all recordings as input is calculated. Included in the testing is also a very similar input data separation, where unequal/equal CDP trace numbers have been selected. Evaluation of dependence upon choice of extrapolation window around the target zone is also included in the testing.

The chosen lines from the 2008 2D seismic survey includes the multiplicity in seismic survey conditions around Vedsted and is therefore considered to contribute with a representative estimate of conditions for time lapse seismic monitoring in the area, including surface conditions. The area is a low lying, highly cultivated and drained area with surface layers of primarily Quaternary marine origin. Marsh areas with peat are common and even moor areas are found.

The relative energy analyses of difference stack in comparison to full stack corresponds very well with the data quality of the full stack of the seismic lines and summarises into:

- relative low energy is consistently related to good seismic data quality of final stack data
- relative high energy is related to more marginal seismic data quality of final stack data
- the relative energy analyses is clearly a diagnostic tool for pre-evaluation of feasibility of time lapse seismic monitoring

The close correspondence between relative energy of difference stack compared to full stack and the seismic data quality for all three lines used for this evaluation suggests a direct evaluation of seismic data quality of all lines in the 2008 survey as part of analysing the feasibility for time lapse seismic monitoring. Further difference stack analyses in areas of marginal data quality are recommended.

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