Geophysical Research Abstracts
Vol. 14, EGU2012-13054, 2012
EGU General Assembly 2012

CO_2 Monitoring at the Sleipner Field with Full Waveform Inversion

A. Romdhane (1), C. Ravaut (2), and E. Querendez (3)

(1) SINTEF Petroleum Research, Trondheim, Norway (anouar.romdhane@sintef.no), (2) STATOIL, Trondheim, Norway (celr@statoil.com), (3) SINTEF Petroleum Research, Trondheim, Norway (etor.querendez@sintef.no)

The injection of large quantities of carbon dioxide (CO_2) into underground reservoir rocks for long-term storage is considered nowadays as a vital part of the solution to the global climate change. In the North Sea, an industrial scale CO_2 storage operation has been piloted since 1994 at the Sleipner field. Approximately 1 million tons of CO_2 per year have been injected at about 1000 m beneath the seabed into a saline reservoir, the Utsira formation.

In this context, the intensive work carried out to quantify the CO_2 saturation distribution from interpreted reflectivity changes in seismic amplitudes revealed to be challenging. The accumulations are within thin layers, causing complex wave propagation modes (inter-bed and surface related multiples) that affect the seismic data.

To overcome some of these difficulties, an alternative consists in using full waveform inversion (FWI). The method has the biggest potential in terms of resolution to quantify the medium properties by reunifying model building and migration tasks and by exploiting the whole information contained in the seismic signal.

The purpose of this work is to apply FWI for CO_2 monitoring at the Sleipner field. We use a 2D non-linear visco-acoustic code formulated in the frequency domain to invert for seismic P-wave velocities.
In a first stage, a feasibility study was carried out on synthetic data to evaluate the capability of FWI to resolve 10 meters thick CO_2 layers. The results are convincing and show that FWI can be a useful method to improve the resolution of the velocity model at Sleipner and help in better characterizing the CO_2 layers velocities and thicknesses if the data are not too noisy.

In a second stage, the method was applied to the Sleipner real data. We defined and applied a specific pre-processing workflow to improve the signal to noise ratio without affecting the amplitudes of the data. We considered the same extracted 2D line from different Sleipner vintages. The results show an improved image of the P-wave velocity in the CO_2 plume compared to the initial velocity model estimated from stacking velocities. Low velocity layers can be observed at the target zone with a thickness varying between 40 m and 60 m. Due to the lack of very low frequencies and the limited acquisition aperture, the results strongly depend on the quality of the initial velocity model.

In a last stage, the inversion results were used to update the migrated image. Different tests were carried out to analyse the contribution of using the P-wave velocity model derived from FWI to perform reverse time migration. Preliminary results give promising perspectives that need to be further investigated. We will in particular compare the changes in P-wave velocities to the amplitude changes in the migrated image and investigate the effect of adding a priori constraints on the inversion results.