Estimation of seismically detectable portion of a gas plume: CO_2CRC Otway project case study

Roman Pevzner (1,3), Eva Caspari (1,3), Andrej Bona (1,3), Robert Galvin (1,3), Boris Gurevich (1,2,3)

(1) Curtin University, Exploration Geophysics, Perth, Australia, (2) CSIRO, Perth, Australia , (3) CO_2CRC

CO_2CRC Otway project comprises of several experiments involving CO_2/CH4 or pure CO_2 gas injection into different geological formations at the Otway test site (Victoria, Australia). During the first stage of the project, which was finished in 2010, more than 64,000 t of gas were injected into the depleted gas reservoir at ∼2 km depth. At the moment, preparations for the next stage of the project aiming to examine capabilities of seismic monitoring of small scale injection (up to 15,000 t) into saline formation are ongoing.

Time-lapse seismic is one of the most typical methods for CO_2 geosequestration monitoring. Significant experience was gained during the first stage of the project through acquisition and analysis of the 4D surface seismic and numerous time-lapse VSP surveys. In order to justify the second stage of the project and optimise parameters of the experiment, several modelling studies were conducted.

In order to predict seismic signal we populate realistic geological model with elastic properties, model their changes using fluid substitution technique applied to the fluid flow simulation results and compute synthetic seismic baseline and monitor volumes.

To assess detectability of the time-lapse signal caused by the injection, we assume that the time-lapse noise level will be equivalent to the level of difference between the last two Otway 3D surveys acquired in 2009 and 2010 using conventional surface technique (15,000 lbs vibroseis sources and single geophones as the receivers).

In order to quantify the uncertainties in plume imaging/visualisation due to the time-lapse noise realisation we propose to use multiple noise realisations with the same F-Kx-Ky amplitude spectra as the field noise for each synthetic signal volume.
Having signal detection criterion defined in the terms of signal/time-

lapse noise level on a single trace we estimate visible portion of the plume as a function of this criterion. This approach also gives an opportunity to attempt to evaluate probability of the signal detection.