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Enhanced imaging of CO_2 at the Ketzin storage site: Inversion of 3D time-lapse seismic data

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The Ketzin test site, located near Berlin, is Europe's longest-operating on-shore CO_2 storage site. As of December 2011, more than 56,000 tons of food grade CO_2 has been injected since June 2008 in an anticlinal structure of the Northeast German Basin. The target reservoir consists of porous, brine bearing sandstone units of the Upper Triassic Stuttgart Formation at approximately 630 to 650 m depth. In order to enhance the understanding of the structural geometry of the site and to investigate the extension of the CO_2-plume, several geophysical monitoring methods are being applied at Ketzin, among these are active seismic measurements, geoelectrics and borehole measurements.

Among the various seismic techniques (e.g. 2D reflection surveys, crosshole tomography, Vertical Seismic Profiling, 2D- and 3D-Moving Source Profiling) employed at this pilot site, 3D time-lapse reflection surveys are an important component. The baseline 3D survey was acquired in 2005 and the first repeat measurements were performed in 2009 after injection of about 22,000 tons of CO_2. The second repeat survey is planned to be carried out in fall 2012. These measurements allow the time-lapse signature of the injected CO_2 to be imaged. The time-lapse amplitude variation attributed to the injected CO_2 in the reservoir matches, considering detection limits of seismic surface measurements, the expected distribution of the CO_2 plume derived from reservoir simulations. Previous attempts towards a quantitative interpretation were based on integrative considerations of different types of geophysical measurements using strict assumptions and characterized by large error bars. In order to increase the resolution and reliability of the data and to improve estimation of rock properties and especially to enhance the imaging resolution of the CO_2-plume, the time-lapse 3D seismic data have now been inverted for seismic impedances with different methods, which is the focus of this presentation. One difficulty in the inversion process was that logs were only available from three wells in the area. However, the velocity model underlying the post-stack inversion, constructed from the geological horizons and the well logs, was extended with lateral velocity variations from the transformed NMO-corrections. The first inversion results show an improvement of time-lapse CO_2-signature in comparison to standard amplitude imaging.