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A Study of the Feasibility of Imaging CO2 Injection at the CO2SINK Project Using Seismic Techniques

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SUMMARY

Ketzin is a pilot project sequestering CO2 in a natural aquifer near the town of Ketzin, Germany. Numerous techniques have been deployed to monitor the CO2 flood - this paper provides modelling relevant to the 4D seismic monitoring taking place late 2009. The purpose of the paper is to assess whether the CO2 plume will show up on the repeat survey, and what seismic attribute(s) will be the most effective in imaging it.

Ketzin is a geologically heterogenous reservoir, where thin sand channels are believed to control the flow of CO2. These channels are below the tuning thickness, so the seismic changes will not necessarily be linear, as reflections from the top and bottom of the channel will interfere. Furthermore, fluid flow modelling suggests that CO2 will not fill up these channels completely, so we must model a thin channel containing an even thinner layer of CO2.

We model the seismic response using simple reflectivity modelling and full waveform finite difference modelling, finding good agreement between the two methods. We find that the presence of CO2 creates detectable amplitude changes, but that there is not enough thickness for a detectable time-shift to accumulate. Amplitude changes increase with increasing CO2 layer thickness, so there will be a minimum detectable thickness determined by the survey repeatability. AVO behaviour is not found to differ significantly after CO2 injection.

We also attempt to invert the seismic response computed using finite difference modelling for the velocity change induced by a CO2 layer, and the thickness of the layer. However, we find that there is a trade-off between layer thickness and the velocity change within that layer. This means that quantitative estimates of CO2 volume in the reservoir - beyond the plume extent - may well be problematic. Flow simulations often indicate that CO2 will form thin layers at the top of a reservoir. This being the case, more work must be focused on imaging CO2 plumes that are similar to or thinner than the tuning thickness.