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VSP Imaging Using Fibre Optic Cable as Receiver Array in Four Wells Simultaneously at the Ketzin CO₂ Storage Pilot Site

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SUMMARY

At the Ketzin pilot site for CO₂ storage, from 2008 through 2013, 67,000 tons of CO₂ were injected into the Triassic Stuttgart Formation, a saline aquifer at 630 m – 650 m depth. For continuous pressure and temperature monitoring over the whole depth range of the wells, a fibre optic cable was deployed in all deep injection and monitoring wells in the annulus outside the production casing. A VSP survey was acquired using a Mertz M12 vibro truck on 23 source points and using the whole length of deployed cable for recording. Seismic waves were recorded over a length of ~5900 m at a trace interval of 1 m. An inspection of the data quality shows that the signal to noise ratio is strongly affected by the coupling conditions of the cable. Within the cemented part of the casing, the coupling is reasonably good, whereas the signal to noise ratio is bad for uncemented intervals. In the lower half of the wells, coupling conditions are good enough to produce high-quality seismic shot gathers. These gathers were used for a 3D imaging of the reservoir complex used for CO₂ storage in close vicinity to the injection and monitoring wells.



At the Ketzin pilot site for CO₂ storage, from 2008 through 2013, 67,000 tons of CO₂ were injected into the Triassic Stuttgart Formation, a saline aquifer at 630 m – 650 m depth. The site's infrastructure includes one injection well and three deep monitoring wells, all of which will be abandoned in spring and summer 2017. For continuous pressure and temperature monitoring over the whole depth range of the wells, a fibre optic cable was deployed in all deep injection and monitoring wells in the annulus outside the production casing. Based on the results of a first field test, using an accelerated weight drop seismic source, a VSP survey was acquired using a Mertz M12 vibro truck on 23 source points and using the whole length of deployed cable for recording. Seismic waves were recorded over a length of ~5900 m at a trace interval of 1 m. The survey was acquired within four days including initial tests and demobilization. An inspection of the data quality shows that the signal to noise ratio is strongly affected by the coupling conditions of the cable. Within the cemented part of the casing, the coupling is reasonably good, whereas the signal to noise ratio is bad for uncemented intervals. In the upper half of the wells, the recorded wavefield is dominated by tube waves and in the lower half of the wells, coupling conditions are good enough to produce high-quality seismic shot gathers. These gathers were used for a 3D imaging of the reservoir complex used for CO₂ storage in close vicinity to the injection and monitoring wells.