# Monitoring CO2 gas-phase injection in a shallow sand aquifer using cross borehole GPR and modeled with T2VOC multi-phase code

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**Monitoring CO2 gas-phase injection in a shallow sand aquifer using cross borehole GPR and modeled with T2VOC multi-phase code**

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**Body:** Risk assessment of potential leakage is an important issue that needs attention in designing effective storage schemes for CO2 storage. Leaking gas may threat groundwater resources and be a liability if pooled up in buildings. We have designed an experiment where we were track the movement of an injected CO2 gas-phase using cross borehole GPR in an unconfined sandy aquifer located in the southwestern part of Denmark.

The geology at the field site has been determined using GPR- data, natural gamma ray logging in boreholes, cores sampled with a Geoprobe soil-sampling tool and grain size analysis of the cores. From these measurements the field site geology can be divided into three geological zones. The first zone is an approximately 4 m fine aeolian sand; the second zone is poorly sorted glacial deposits dominated by sand down to 9 m; and the the last zone from 9 m and down consist of well-sorted medium melt water sand.

In total we conducted four short injection experiments all of them producing very similar results. The screen of the injection well was 10 m below ground level or 8 m below the water table. An array of six GPR boreholes was installed around the injection well and downwards of dominating gas flow direction. GPR-data were acquired in zero-offset (1D) and multiple-offset (2D) configurations prior and during the injection. All sets of GPR data showed that a plume developed at the depth of the injection screen and that the injected gas primarily spread towards South-East and never breach a barrier around 5 m depth. This corresponded very well with the natural gamma logs, which resulted in higher readings from 4-6.5 m depth. The grain size analyses confirmed that there is a fine sediment layer throughout the area at 4-6 meters depth.

We guesstimated van Genucthen parameters from the grain size analysis and used as input to the numerical model and GPR data were used for calibration. The numerical model enabled us to test minimum entry pressure required for the fine sediment layer to function as a barrier and the “leakage” rate required for the gas phase to breach the barrier.