

Seismic reservoir characterization of an aquifer gas storage (CCUS) in Denmark: Part 1

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Summary

Subsurface storage of carbon dioxide (CO₂) requires a secure geological container. This container not only needs to be large and porous enough to hold the CO₂, but the container must also be sufficiently permeable to accommodate the required rates of CO₂ injection. Fractures also play a role in containment and are a function of the present-day stress conditions. For these reasons, seismic reservoir characterization plays an important role for carbon capture and storage analysis. The Havnsø anticlinal structure in Denmark is a prospective CO₂ storage site due to its proximity to two large emission sources - a coal-fired power station and a nearby refinery. Although legacy 2D seismic lines over the area outline the anticline structure, their quality is insufficient for more quantitative amplitude analysis such as impedance inversion. Fortunately, we have access to a 3D seismic survey acquired in 1997 over an underground natural gas storage facility in the Stenlille aquifer approximately 30 km to the southeast of the Havnsø structure. Although no prestack seismic data are available, the Stenlille aquifer is a good analog to the Gassum Formation at Havnsø. We therefore apply modern reservoir characterization analysis of the existing natural gas storage container at Stenlille to provide insight into the proposed CO₂ storage at Havnsø.

Using the limited poststack seismic data available, we estimate the impedance of the Stenlille Gassum formation through generation of an accurate low-frequency model. Because the storage capacity is a function of both the formation volume and porosity, we apply a multiattribute regression analysis to generate volumetric estimates of porosity, gamma-ray, and water-saturation within the container. We then use the resulting porosity and gamma-ray volumes and Bayesian classification to predict the probability of each of the more important lithofacies, namely sand, shale, moderate porosity sand, moderate porosity shaly sand, etc.