

Predictive Modelling for Plume Detection in CCUS

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Summary

This talk will outline the considerations for predictive modelling of CO₂ sequestration in potential subsurface reservoirs. There are a number of considerations and data required to fully understand and enable prediction of the potential plume growth upon injection. These include understanding and modelling of the host rock, modelling the injected fluids, the ability to detect the plume and thresholds as well as anticipated fluid saturations over time. These considerations will be discussed as well as workflows to achieve future detection.

Theory

Input data into a predictive model needs to be gathered and analyzed to best characterize the reservoir that is contemplated for CO₂ injection. Discussions with reservoir specialists are best to understand the anticipated injection depths and intervals contemplated.

Data prep and analysis should revolve around suitable well log data as input into the model which may include data editing to consider effects of the model extent and data frequencies and phases. The latter is subject to either existing subsurface seismic control and/or anticipated future seismic control.

A baseline model is generated and compared to existing seismic control for validity of the initial model state prior to modelling of the plume. Considerations for baseline models also include any existing operations in nearby areas that may complicate the baseline understanding, such as current injection schemes or proximal hydrocarbon bearing zones.

Considerations for CO₂ saturations and their effect on model velocities need to be incorporated into the predictive model to understand the differences from the baseline model. The saturation modelling may feature varying saturations over time or initial variations of injection volumes.

The baseline model and the saturation model then can be compared and characterized based on changes in the model over time, data frequencies, and so forth, subject to the operator's anticipated plans. From there, important questions of plume detection and threshold detection can be addressed.

Results

The results of forward modelling for CO₂ injection in a potential subsurface reservoir are shown below. Figure 1 shows seismic response changes from the baseline to the CO₂ injected formation, from left to right. Figure 2 shows the relative amplitude changes in the injected zone (Mkr 1) versus a formation that received no injection (Mkr 2). The response of both is indicated in the graph as a function of CO₂ saturation over time. In this case it is anticipated that the CO₂ would be able to be monitored within the proposed formation given these input parameters and data frequencies in a given area. Furthermore, the threshold of detection, as a function of time and a seismic attribute, can be determined from this model.

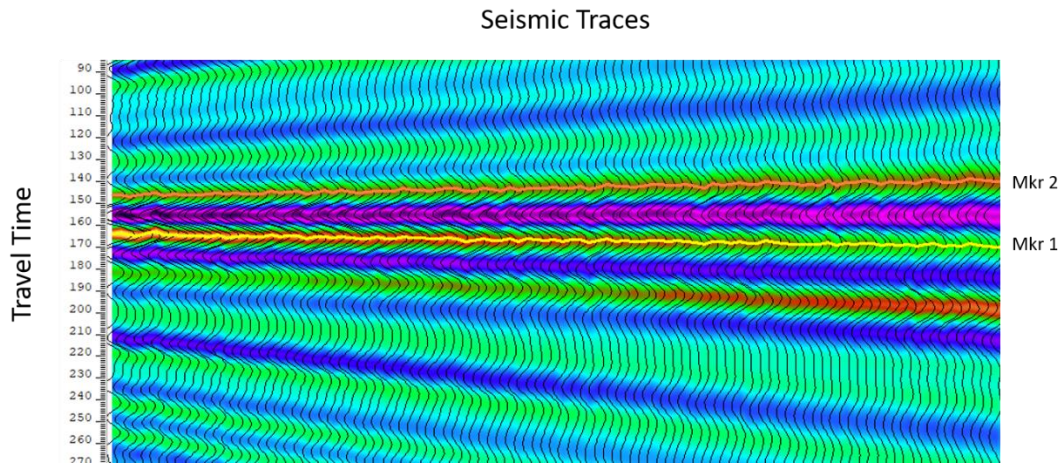


Figure 1: Synthetic model of CO₂ saturation of a subsurface reservoir over time.

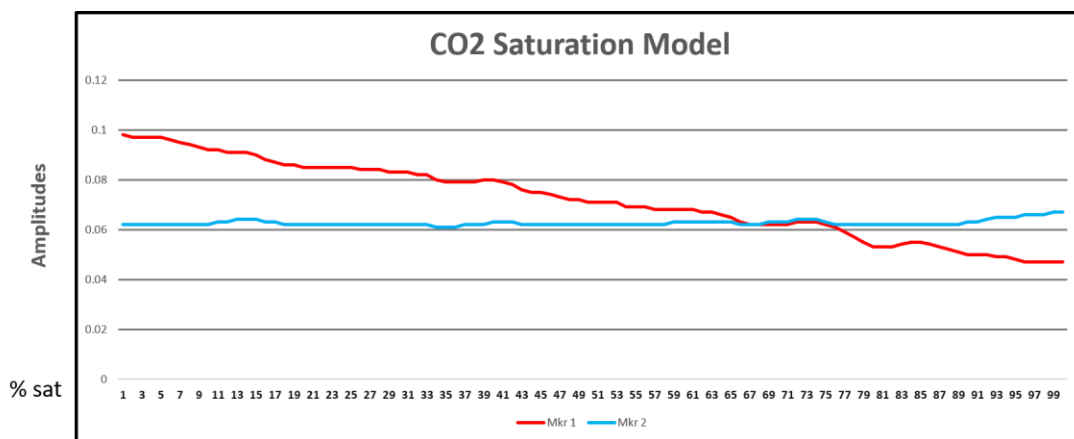


Figure 2: CO₂ saturation response in terms of seismic amplitude variations for a given formation.

Conclusions

By constructing and generating a forward model for a given subsurface formation, CO₂ plume detection and mapping can be assessed for viability in a given project area. This model can help potential CCUS operators get a sense of whether the CO₂ injection will be detectable from a sub-surface seismic method and what the detection thresholds may be over a given area as well as a sense of project timelines. This in turn serves as valuable information for project pilot planning, budget estimates for MMV, consideration of likely MMV technologies to apply as well as useful information for nearby stakeholders, operators and government regulators.

Novel/Additive Information

The talk provides information about a modelling workflow that greatly benefits a potential CCUS project in terms of MMV capability, operational considerations, project budgeting and planning.

References

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