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Geological investigation for CO2 storage: from seismic and well data to storage design

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The main purpose of this study is to evaluate the techno-economical potential of storing 200 000 tCO2 per year produced by a sugar beat distillery. To reach this goal, an accurate hydro-geological characterisation of a CO2 injection site is of primary importance because it will strongly influence the site selection, the storage design and the risk management. Geological investigation for CO2 storage is usually set in the center or deepest part of sedimentary basins. However, CO2 producers do not always match with the geological settings, and so other geological configurations have to be studied. This is the aim of this project, which is located near the South-West border of the Paris Basin, in the Orléans region. Special geometries such as onlaps and pinch out of formation against the basement are likely to be observed and so have to be taken into account.
Two deep saline aquifers are potentially good candidates for CO2 storage. The Triassic continental deposits capped by the Upper Triassic/Lower Jurassic continental shales and the Dogger carbonate deposits capped by the Callovian and Oxfordian shales.
First, a data review was undertaken, to provide the palaeogeographical settings and ideas about the facies, thicknesses and depth of the targeted formations. It was followed by a seismic interpretation. Three hundred kilometres of seismic lines were reprocessed and interpreted to characterize the geometry of the studied area. The main structure identified is the Étampes fault that affects all the formations. Apart from the vicinity of the fault where drag folds appear, the layers are sub-horizontal and gently dip and thicken eastwards.
Then, interpreted seismic lines, together with well data from more than 50 boreholes were integrated into a 2D-model of the main surfaces using geostatistics (Isatis® and Petrel® softwares). The main difficulty of this step was to generate a realistic model accounting for both the specific geometries linked to the basin border (onlapping, pinching out...) and the faults. If the former only concerns the Triassic, the latter also affects the overlying formations. Regarding the Dogger top surface, it is less than 700m deep in the western area, which is too shallow for supercritical state injection.
Consequently, the next part of the study focused on the Triassic reservoir and integrated changes in petrophysical properties as a function of lateral lithological variation. This ultimately led to upgrade the model from 2D to 3D in order to perform the simulation of CO2 migration. To achieve this objective, we first applied sequence stratigraphy concepts on Triassic deposits to compensate the lack of quantitative petrophysical data. It provided qualitative data about the reservoir heterogeneities which are crucial for a realistic 3D-modelling. Paleoenvironmental reconstructions show that the sediment supply direction is WSW-ENE, implying more proximal deposits to the West, and so better reservoir properties.
The final step is to use this 3D-model to elaborate a flow model to estimate the injectivity rate and the extension of the overpressure within the open aquifer and the CO2 plume after 30 years of injection. Two injection rates as well as two well locations were hypothesized into four scenarios considering several locations and injections

rates. In any case, the fault has been considered as a barrier to the CO2 migration and the system as a closed one. In the four cases, results are satisfying, the overpressure is less than 30% of the initial pressure and the reservoir capacity is enough regarding the goal of the project.

The results of these simulations will then be integrated into the risk analysis of the project, which is of utmost importance to ensure safety and cope with public acceptance.

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