Coupling 3D Basin and Geomechanical Modelling for CO_2 Storage Capacity Evaluation in Deep Saline Aquifers – Insigths from the Paris Basin (France)

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Abstract

Successful CO_2 storage in deep saline aquifers rely on functional 3D numerical models of the storage complex with the real geometry and conditions. Such models require extensive computational power, very good data-coverage as well as a detailed geological knowledge of the working area. In particular, understanding of the geological characteristics of the reservoir rocks, such as their structural pattern, facies evolution through time and space, petrophysical and geomechanical properties, is key for a full and safe CO_2 storage management.

This study presents an efficient workflow for constructing an accurate geological basin model for the evaluation of CO_2 storage capacity. This workflow has been developed in the general framework of a jointed IFPEN-TotalEnergies collaboration on a CCUS project focused in the Bathonian reservoir of the Paris Basin (France). The Paris Basin is one of the most mature areas in the Western Europe in terms of the oil and gas exploration, with approximately 100 oil fields producing since the 1950's. This extensive exploration activity gave a lot of information of the subsurface via more than 850 exploration wells as well as seismic, which can be used nowadays for other disciplines such as CO_2 storage.

Our multidisciplinary and integrated workflow covers three main steps. Firstly, we built a 3D basin model simulating the evolution of the Paris Basin through time, by integrating diverse geological, geochemical and reservoir engineering data. The 3D basin model was then coupled with a comprehensive 4D forward stratigraphic model, which gives greater insight into the facies architecture and the distribution of potential reservoir rocks of the Bathonian reservoir through geological time. Finally, we performed an advanced 3D geomechanical analysis in the model, that allowed us to simulate the present-day distribution of fundamental basin parameters such as 3D stress tensor, porosity, pore-pressure and temperature. The resulting 3D basin model was then used for reservoir modelling purposes, and as input to model the injection of CO_2 and its long-term effects on the pressure field.