Structural-geological models of the Ketzin CO_2 storage pilot site used for site evaluation, dynamic reservoir simulations, and monitoring purposes

Ben Norden (1), Christian Kling (1,2), Peter Frykman (3), and Charlotte M. Krawczyk (4)

(1) German Research Centre for Geosciences GFZ, Hemholtz Centre Potsdam, 4.1 Reservoir Technologies, Germany (ben.norden@gfz-potsdam.de), (2) now at OMV Exploration & Production GmbH, Vienna, Austria, (3) Geological Survey of Denmark and Greenland GEUS, Ø. Voldgade 10, 1350 Copenhagen, Denmark, (4) Leibniz Institute of Applied Geophysics LIAG, Stilleweg 2, Hannover, Germany

The saline aquifer of the Stuttgart Formation (Upper Triassic) is used for a carbon dioxide (CO_2) storage research project at Ketzin, about 25 km west of Berlin (Germany). The structural and lithological site characterization relies on a comprehensive data set, consisting of former exploration data (hydrocarbon and natural gas storage exploration) and of the recent exploration, production, and monitoring data acquired at the CO_2 pilot site. The quality of the data in terms of resolution and documentation is variable, covering also different scales. We present an overview of the structural and lithological characterization of the Ketzin CO_2 pilot site that is based on the evolution of the geological models prepared for storage site development and site operation.

In order to be able to assess risk elements, especially in the early regulatory and permitting stages of the project, the geological model building concentrated on two scales: Firstly, the site scale (called geo-model, comprising the reservoir and its overburden), and, secondly, the reservoir scale, using a higher resolution. The reservoir scale was applied to the target horizon of the CO_2 storage (the Triassic Stuttgart Formation) and the Quaternary to Tertiary layers, presenting the near-surface groundwater system.

The first geo-models illustrate the geological setting of the Ketzin site as a part of a salt-anticlinal structure based on seismic legacy data. These models were used to give first estimates on the deep natural groundwater flow and to establish pre-drilling profiles, but could not give reliable information on the existence and distribution of faults. Nevertheless, the estimated bed boundaries of the Stuttgart Formation served as an input for the construction of the first reservoir models of the Stuttgart Formation which were used to illustrate the expected variability and heterogeneity in rock properties. The target formation is lithologically very heterogeneous, reflecting a complex fluviatile facies distribution pattern: sandy rocks of the channel facies are embedded in muddy rocks of the floodplain facies. The facies distribution and its hydraulic parameterization were modeled using a stochastic approach.

After the processing of the 3D seismic data acquired in 2005, and the drilling of three boreholes in Ketzin in 2007, the need of a re-interpretation of the geological models was given to account for the higher resolution of the new input data. In the revised models it was possible to map the main faults at the site with good accuracy. In addition, seismic facies analysis was performed by applying a spectral decomposition technique to the 3D seismic data. Thereby, subsurface features could be identified, which may indicate to some degree the distribution of the fluvial channel facies of the reservoir formation. This data was then also used to guide the stochastic reservoir modeling of the Stuttgart Formation. In addition, the interpretation of seismic CO_2 monitoring data gives further evidence of the mean CO_2 distribution in the subsurface and could partly guide the structural interpretation. This data enables a local deterministic refinement of the stochastic reservoir model. Finally, another well drilled into the storage formation in 2012 serves as an additional input to the geological models.