GEOLOGY PAPER 11

DYNAMIC MODELLING OF A NORTH SEA SALINE FORMATION FOR CARBON SEQUESTRATION

Francesca E. Watson[1,2]*, Benjamin J. Hedley[2], Richard J. Davies[2] & Susie E. Daniels[1]

[1]Geospatial Research Ltd., Dept. of Earth Sciences, Durham University, Durham DH1 3LE, UK.
[2]Dept. of Earth Sciences, Durham University, Durham DH1 3LE, UK.
*f.e.watson@durham.ac.uk

Carbon capture and storage has been proposed as a way of stabilising greenhouse gas emissions in order to meet global greenhouse gas emissions targets. A thorough characterisation of potential CO_2 storage sites is required prior to CO_2 injection. European Directive 2009/31/EC (European Parliament, 2009) states that this should include dynamic modelling of the proposed storage site. This paper describes the results of the dynamic modelling carried out on a deep saline formation in the UK North Sea.

The target formation for CO_2 sequestration is the Permian Rotliegend sandstone, Central North Sea, approximately 40 km west of the Central Graben and 200 km north east of the Teeside industrial processing region, northeast England. The seal is the overlying Permian Zechstein salt. Seismic data show that the Rotliegend sandstone dips to the north east and pinches out to the southwest, forming a stratigraphic trap on a regional scale. Local dip closures within the Rotliegend sandstone have also been identified as possible locations for carbon dioxide injection, in addition to the stratigraphic closure.

The site is not penetrated by wells but the structure is defined by 2D reconnaissance seismic data tied to adjacent exploration wells. Horizons interpreted from the seismic survey have been used to build a 2D dynamic model. The model consists of a layer of Rotliegend sandstone approximately 100 m thick underneath a layer of Zechstein salt which is approximately 600 m thick. Both the Rotliegend and Zechstein layers are considered to be homogeneous due to the absence of resolvable internal seismic structures. The topography of the interface between the sandstone and the salt has been imported from the seismic interpretation of the top Rotliegend surface. The base of the Rotliegend sandstone

Warta Geologi (Newsletter of the Geological Society of Malaysia), Vol. 37, No. 1, January-March 2011

has been modelled as both a flat and a dipping planar surface. This takes into account different interpretations of the location of the bottom of the Rotliegend which is difficult to distinguish in the seismic data. The model has been populated with rock and fluid properties using data from literature, sonic logs and results from core flood experiments.

Modelling has been performed using TOUGH2-MP (Zhang et al., 2008), the parallel version of the TOUGH2 numerical code for modelling multiphase fluid and heat flow in porous media. It has been used in conjunction with the ECO2N equation of state module (Pruess, K., 2005) which models mixtures of H_2O-CO_2-NaCl designed specifically to represent conditions applicable to CO¬2 storage in deep saline formations.

Several models have been developed to explore the effect of different parameters on the behaviour of the injected CO_2 and the response of the reservoir to CO_2 injection. Best and worst case scenarios with respect to rock and fluid properties and reservoir geometry have been assessed. Also different injection scenarios have been considered for instance different well positions, injection rates and number of wells.

REFERENCES

EUROPEAN PARLIAMENT, 2009. Directive 2009/31/EC of the European Parliament and of the council of 23 April 2009. Official Journal of the European Union.

PRUESS, K., 2005. ECO2N: A TOUGH2 fluid property module for mixtures of Water, NaCl and CO2. Earth Sciences Division, Lawrence Berkeley National Laboratory. LBNL-57952.

ZHANG, K., WU, Y. & PRUESS, K., 2008. User's Guide for TOUGH2-MP - A Massively

Parallel Version of the TOUGH2 Code. Earth Sciences Division, Lawrence Berkeley National Laboratory. LBNL-315E.