CO_2-EOR and storage by CO_2 injection in North Sea formations

Per Eirik S. Bergmo[1*] and Idar Akervoll[1]
[1] SINTEF Petroleum Research, Trondheim, Norway
[*]per.bergmo@sintef.no

Keywords: CO_2-EOR, CO_2 storage, Reservoir simulation, North Sea

Abstract

In the North Sea a majority of the oil reservoirs have been subject to massive strategic and efficient water flooding resulting in high recoveries for most of the cases. However, more advanced tertiary recovery methods are sought to increase the recovery including CO_2 injection. Results from simulations of CO_2 injection and CO_2-WAG (water-alternating-gas) injection for enhanced oil recovery (EOR) and CO_2-storage purpose in reservoir models representative of water flooded oil reservoirs in the North Sea is presented. EOR by CO_2 injection is attractive because it has the combined potential of EOR from producing fields and at the end of the lifetime of the operation, the potential to store CO_2.

Conceptual North Sea reservoir models from the productive Brent-type sandstone oil reservoirs have been constructed. The construction of for example the fluvial deposit conceptual model is based on the formation properties of the Ness formation containing highly conductive sand channels in a background of low permeability mud stones. Target for CO_2-EOR in this setting is capillary trapped residual oil and bypassed oil in the low permeability zones. Porosity and permeability in the model has been stochastically generated and the distribution of permeability shown in Figure 1 clearly shows the contour of a river in the top layer (rivers in deeper layers are seen at the edges of the model). The selected Brent sands for this study represent fluvial and shallow marine deposition environments of Jurassic age.

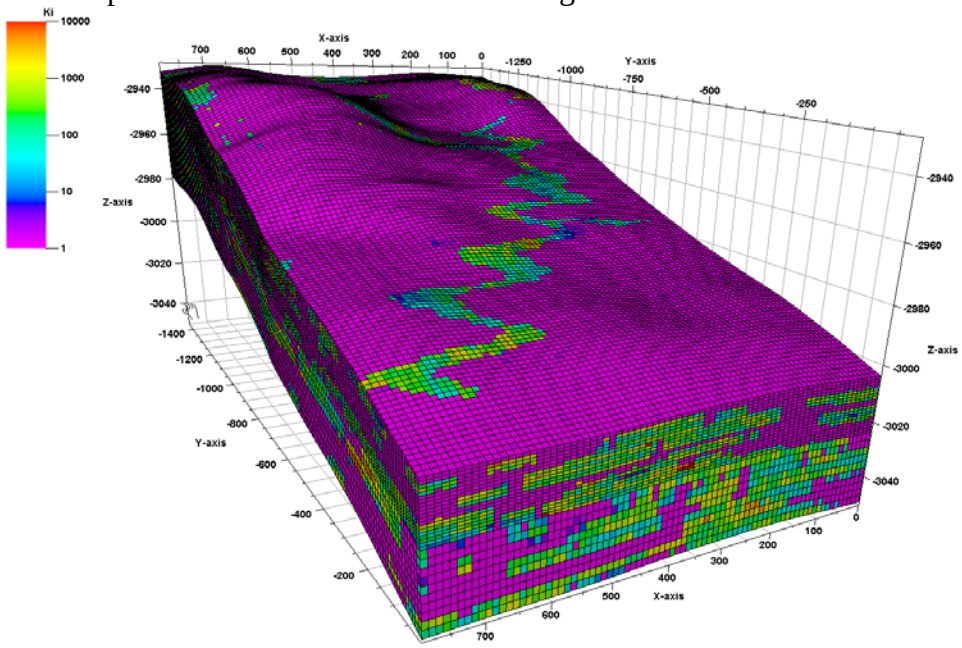

Figure 1: Permeability distribution in the conceptual sector model representing fluvial deposits.

The North Sea shows a great variation in type of oil reservoirs and traps. Conceptual live reservoir oil is constructed to represent fluid properties of a selection of more than 50 water flooded oil reservoirs from UK, Danish and Norwegian sectors in the North Sea which all can be considered potential candidates for CO_2 injection. The conceptual fluid model is composed and tuned to reflect the hydrocarbon pore volume (HCPV) weighted average properties of these oil reservoirs. Changing the gas-oil ratio effectively changes the density and viscosity of the oil to account for the main variation in the fluid data.

To cover the range of different geological classes, traps and recovery strategies a large number of scenarios has been simulated on the conceptual models. The parameter sensitivity set-up for the CO_2-WAG injections resulted in a total of 648 cases for each of the two deposition environments. The CO_2 injection cases counts half of the WAG cases and the water injection cases (for reference) count to half of that again.

Results from simulation runs will be presented where the effect of reservoir parameters on the oil recovery efficiency and CO_2 storage volumes will be emphasized. The EOR profiles of CO_2-WAG injection beyond water flooding in conceptual North Sea shallow marine deposit is presented in Figure 2.

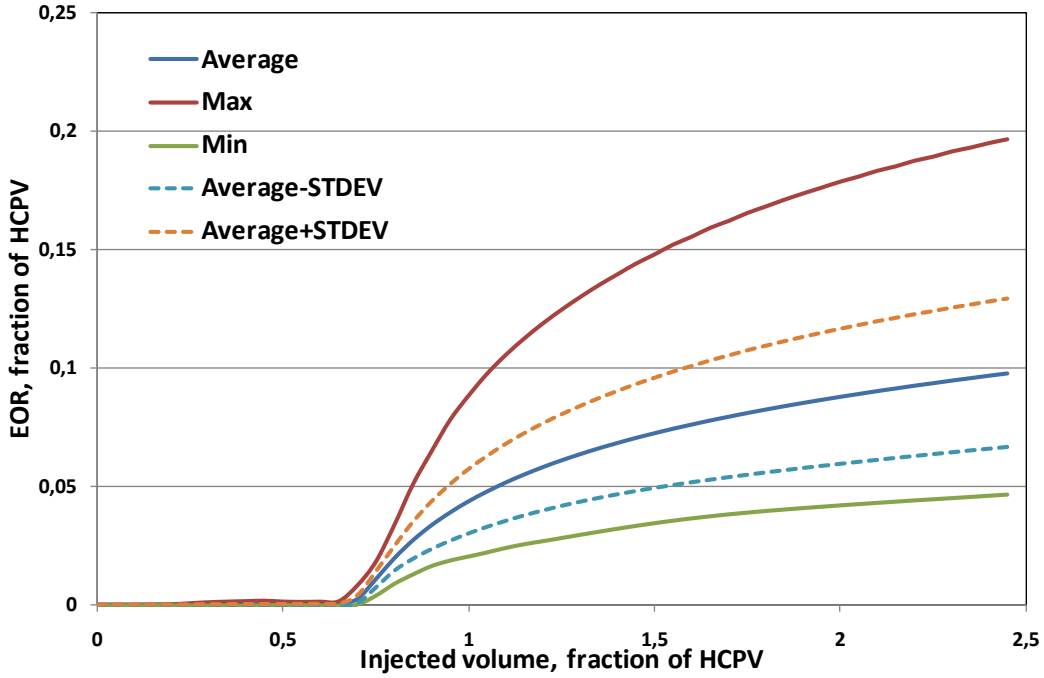

Figure 2: EOR efficiency (beyond oil recovery by water flooding) from simulations of CO_2-WAG injection in North Sea shallow marine conceptual models.

Acknowledgements: The research leading to these results has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 218868 (The ECCO project).