Geophysical Research Abstracts
Vol. 18, EGU2016-17079, 2016
EGU General Assembly 2016

Geo-mechanical consequences of large scale fluid storage in the Utsira formation in the North Sea

Magnus Wangen, Sarah Gasda, and Tore Bjørnarå
(Magnus.Wangen@ife.no)

The Utsira formation in the North Sea is a more than 400 km long formation of Pliocene sand with a thickness in the range from 50m to 350m. The porosity of the Utsira formation is estimated to 35% and the permeability is of the order Darcy (1e-12 m2). This formation is being considered as a possible site for large scale CO_2 storage, because of its large storage capacity and good permeability. In this work we look at the geo-mechanical implications of injecting "large" volumes of fluid in the Utsira formation. Our modelling is based on Biot's poro-elasticity in combination with one-phase and two phase flow. We compare the pressure build-up from injection of brine with the pressure build-up from from injection of supercritical CO_2. Well placement and near well modelling is not a part of the modelling. We study four different injection scenarios over 25 years, which have injection rates: 1 Mt/year, 10 Mt/year, 100 Mt/year and 1000 Mt/year. We observe that the pressure plume scales with the injection rate, which is the same behaviour as with Theis solution for pressure build-up. A particular concern is the mechanical properties of the Utsira sand and the cap rock. The cap rock is a Quaternary shale with a Young's modulus measured to 0.25 GPa and a Poisson ratio 0.25. A Young's modulus for the Utsira sand, which can be used to model expansion of the formation, is not measured. It is reasonable to assume that the loose sand has a low Young's modulus. We have tested low values of the Young's modulus for the sand and we get considerable mechanical expansion of the Utsira formation, even in the case of low pressure build-up from the fluid injection. Almost all the surface (seabed) uplift is linked to mechanical expansion of the sand. The strain of the Utsira formation and related surface uplift can be estimated with simple 1D models. Vertical 1D models apply because of the large lateral extent of the pressure plume compared to the thickness of the formation. The limits of poro-elastic expansion are unknown for the Utsira sand. It is therefore difficult to make reliable predictions for large scale deformations of reservoir rock. At a given maximum poro-elastic strain it is expected that the poro-elasticity ceases to apply, because the grain frame work has reached a state of minimum contact.