Geophysical Research Abstracts
Vol. 18, EGU2016-16465, 2016
EGU General Assembly 2016

Caprock Integrity during Hydrocarbon Production and CO_2 Injection in the Goldeneye Reservoir

Saeed Salimzadeh, Adriana Paluszny, and Robert Zimmerman
Department of Earth Science and Engineering, Imperial College, London, United Kingdom

Carbon Capture and Storage (CCS) is a key technology for addressing climate change and maintaining security of energy supplies, while potentially offering important economic benefits. UK offshore, depleted hydrocarbon reservoirs have the potential capacity to store significant quantities of carbon dioxide, produced during power generation from fossil fuels. The Goldeneye depleted gas condensate field, located offshore in the UK North Sea at a depth of $\sim$ 2600 m, is a candidate for the storage of at least 10 million tons of CO_2. In this research, a fully coupled, full-scale model (50$\times$20$\times$8 km), based on the Goldeneye reservoir, is built and used for hydro-carbon production and CO_2 injection simulations. The model accounts for fluid flow, heat transfer, and deformation of the fractured reservoir. Flow through fractures is defined as two-dimensional laminar flow within the three-dimensional poroelastic medium. The local thermal non-equilibrium between injected CO_2 and host reservoir has been considered with convective (conduction and advection) heat transfer. The numerical model has been developed using standard finite element method with Galerkin spatial discretisation, and finite difference temporal discretisation. The geomechanical model has been implemented into the object-oriented Imperial College Geomechanics Toolkit, in close interaction with the Complex Systems Modelling Platform (CSMP), and validated with several benchmark examples. Fifteen major faults are mapped from the Goldeneye field into the model. Modal stress intensity factors, for the three modes of fracture opening during hydrocarbon production and CO_2 injection phases, are computed at the tips of the faults by computing the I-Integral over a virtual disk. Contact stresses -normal and shear- on the fault surfaces are iteratively computed using a gap-based augmented Lagrangian-Uzawa method. Results show fault activation during the production phase that may affect the fault's hydraulic conductivity and its connection to the reservoir rocks. The direction of growth is downward during production and it is expected to be upward during injection. Elevated fluid pressures inside faults during CO_2 injection may further facilitate fault activation by reducing normal effective stresses. Activated faults can act as permeable conduits and potentially jeopardise caprock integrity for CO_2 storage purposes.