Field-scale three-dimensional geomechanical modelling of gas reservoirs: workflow and case studies

B. Orlic, B.B.T. Wassing
TNO Geo-energy, P.O. Box 80015, 3508 TA Utrecht, The Netherlands
bogdan.orlic@tno.nl

Gas production and fluid injection into the subsurface will induce the poro-mechanical and thermal effects that can mechanically damage rock formations, re-activate pre-existing fractures and geological faults, create new fractures and cause subsidence at the ground surface. The geomechanical effects can play an important role in the production of hydrocarbons or the use of depleted fields as natural gas storage sites or CO_2 disposal sites. Assessment of depletion- and injection-related geomechanical effects can in many cases be done by using analytical and semi-analytical approaches, and 2D numerical models. The use of large-scale, 3D numerical geomechanical models is however required in cases of complex reservoir structures and the spatial variability of material properties that have significant bearings on the gemechanical response of reservoir.

We will present a workflow for construction of 3D finite element meshes from geometrically complex structural geological surface-based models. Several examples will be presented to illustrate the use of field-scale finite element models of real gas reservoirs for different purposes: (i) prediction of subsidence due to gas extraction from gas fields in the Northern Adriatic, Italy; (ii) assessment of the potential for fault reactivation and induced seismicity during underground gas storage operations in the Netherlands; and (iii) evaluation of the geomechanical effects of CO_2 injection and storage in a depleted gas reservoir in Poland.