EAGE

RM20

Geomechanics, Faults and Fractures Modelling

T. Finkbeiner* (Baker Hughes)

SUMMARY

In recent years, the petroleum industry achieved marked advances in the development of full 3D geomechanical models (both static as well as dynamic). If robust, these 3D models provide the benefit for more accurate well and field development planning in structurally complex settings such as areas with significant topography or/and faulting, or/and when substantial pore pressure changes in response to injection or/and depletion are likely to cause changes in the in situ stress field. These stress changes may then be accompanied by phenomena such as fault and fracture reactivation, reservoir compaction and surface subsidence etc. Furthermore, proper 3D geomechanical modeling is often required when wells are planned to intersect salt diapirs or other frictionless bodies/layers with different material characteristics. In many cases, these 3D geomechanical models also require advanced finite element modeling coupled with reservoir simulation. To maximize the value from such modeling, in particular understanding the in situ stresses, pore pressure, and material properties and their variability (lateral, in depth as well as with time) are of critical importance to better evaluate and mitigate risk during the drilling, completion, and production phase of a field development. In other words, a sound and accurate 3D structural model is critically important, since it not only covers the structural elements and layering (stratigraphy) of the reservoir but also the overburden all the way to the surface (or seafloor in offshore environments); it thereby provides the basis for a 3D geomechanical model. When combined with a well calibrated fracture network model (e.g., DFN), 3D geomechanical models can be utilized to investigate the possibility for natural fractures to be or become critically-stressed in response to production or injection and evaluate the impact on the reservoir-wide permeability tensor as a function of time.
This presentation will provide an overview of the basics of 3D static as well as dynamic geomechanics and how it is linked and integrated with structural modeling, discrete fracture network models as well reservoir simulation. Current model limitations and a future outlook as to where technology develop is and should head is also included in the discussion.

In recent years, the petroleum industry achieved marked advances in the development of full 3D geomechanical models (both static as well as dynamic). If robust, these 3D models provide the benefit for more accurate well and field development planning in structurally complex settings such as areas with significant topography or/and faulting, or/and when substantial pore pressure changes in response to injection or/and depletion are likely to cause changes in the in situ stress field. These stress changes may then be accompanied by phenomena such as fault and fracture reactivation, reservoir compaction and surface subsidence etc. Furthermore, proper 3D geomechanical modeling is often required when wells are planned to intersect salt diapirs or other frictionless bodies/layers with different material characteristics. In many cases, these 3D geomechanical models also require advanced finite element modeling coupled with reservoir simulation. To maximize the value from such modeling, in particular understanding the in situ stresses, pore pressure, and material properties and their variability (lateral, in depth as well as with time) are of critical importance to better evaluate and mitigate risk during the drilling, completion, and production phase of a field development. In other words, a sound and accurate 3D structural model is critically important, since it not only covers the structural elements and layering (stratigraphy) of the reservoir but also the overburden all the way to the surface (or seafloor in offshore environments); it thereby provides the basis for a 3D geomechanical model. When combined with a well calibrated fracture network model (e.g., DFN), 3D geomechanical models can be utilized to investigate the possibility for natural fractures to be or become critically-stressed in response to production or injection and evaluate the impact on the reservoir-wide permeability tensor as a function of time.

This presentation will provide an overview of the basics of 3D static as well as dynamic geomechanics and how it is linked and integrated with structural modeling, discrete fracture network models as well reservoir simulation. Current model limitations and a future outlook as to where technology develop is and should head is also included in the discussion.