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Petrel Reservoir Geomechanics

An integrated and efficient environment for advanced geomechanics modeling

APPLICATIONS

- Assessing and mitigating geomechanical risks
- Modeling complex environments
- Drilling, well construction, and well survivability
- Underground gas storage, CO_2 disposal, and enhanced oil recovery

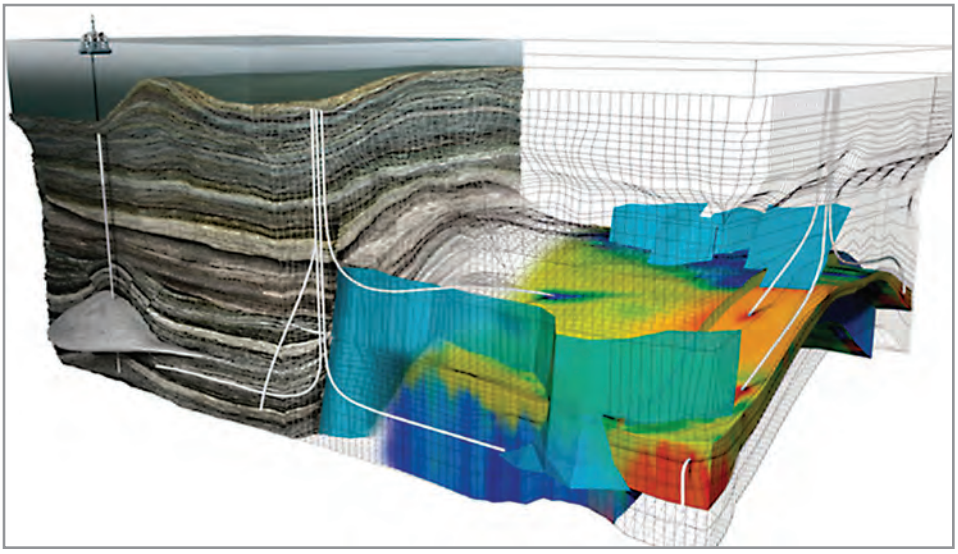
BENEFITS

- Improve field characterization and engineering designs
- Understand geomechanics effects, from exploration to abandonment
- Predict overburden movements and potential environmental impact
- Perform reservoir, fault, and cap-rock integrity studies
- Evaluate geomechanics effects in 4D seismic
- Benefit from improved stimulation design and optimization

FEATURES

- Incorporates subsurface complexity not achieved in single-well analyses
- Supports geomechanics specialists and generalist users
- Operates in self-contained workflow within the Petrel* platform
- Provides pre- and postprocessing for geomechanics simulation
- Create new or adapt existing subsurface models
- Populate properties using seismic, log, well, core, and test data
- Supports multimillion-cell models
- Incorporates single-well geomechanics models
- Couples to reservoir simulation models
- Enables parallel geomechanics simulation

Geomechanics phenomena—including subsurface stresses, rock deformations, and well or pipeline failure—have the potential to adversely impact exploration drilling, field-development, and production operations. To make optimal decisions throughout the life of the asset and accurately assess risks, engineers and geoscientists must consider, from the outset, the geomechanical behavior of their reservoirs and the surrounding formations.



A 3D mechanical earth model of a faulted reservoir and surrounding formations.

Petrel Reservoir Geomechanics software provides an integrated and efficient environment for 3D preproduction geomechanics modeling and for 4D geomechanics modeling of fields under operation. The powerful functionality of the VISAGE* reservoir geomechanics simulator is combined seamlessly with other interpretation, modeling, and engineering workflows in the Petrel E&P software platform. This allows geomechanics experts and non-experts alike to incorporate geomechanics analyses into their existing reservoir or structural models, or to create new subsurface models for geomechanics simulation.

Simulations incorporating time

During exploration work and in early field life, 3D preproduction geomechanics modeling allows companies assess potential drilling risks, reduce nonproductive time (NPT), and avoid unexpected complications or increased well costs.

When coupled with reservoir simulation to incorporate time, 4D models allow operators to predict stress changes, deformation, and rock failure that might occur later in the life of their field. This allows geoscientists and engineers to assess formation compaction and overburden movements that may impact well/completion survivability, potential for solids production, inadvertent loss of reservoir containment and out-of-zone injection, changes in reservoir characteristics and performance, and induced rock failure and seismicity. The same models can also be used to support optimization of recovery schemes and stimulation operations.

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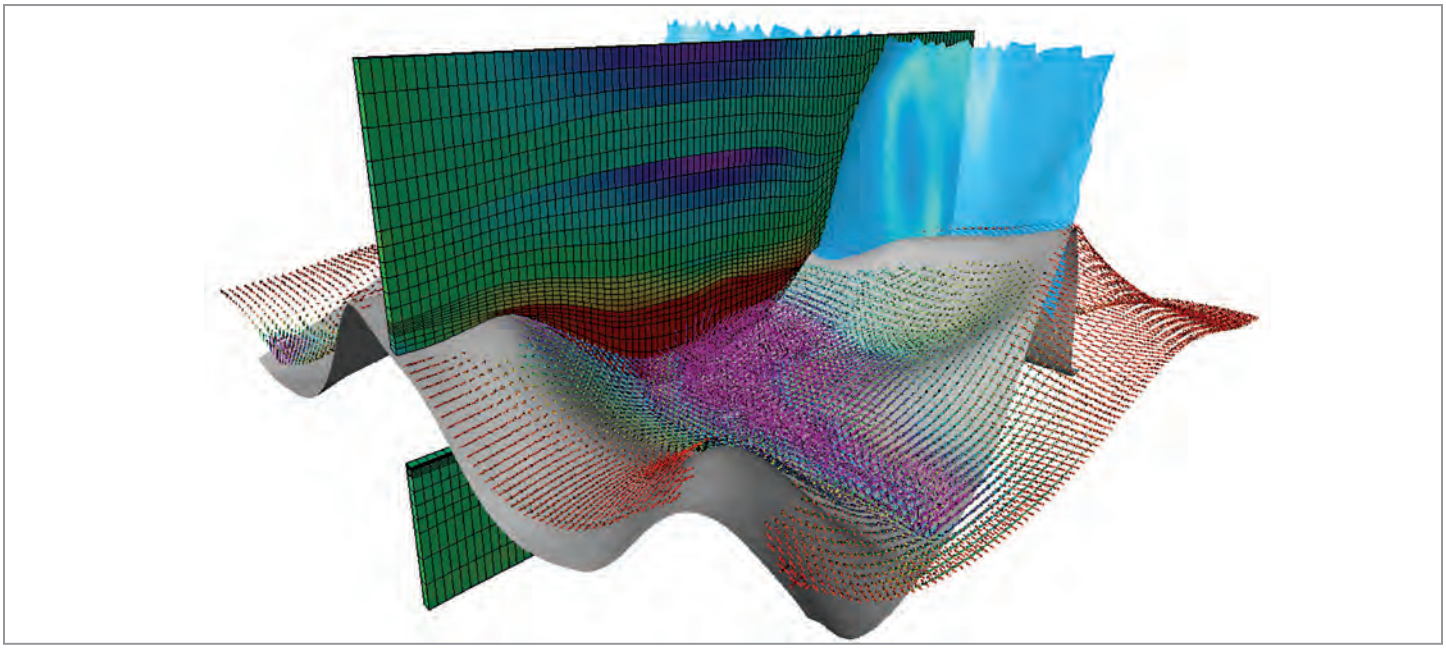


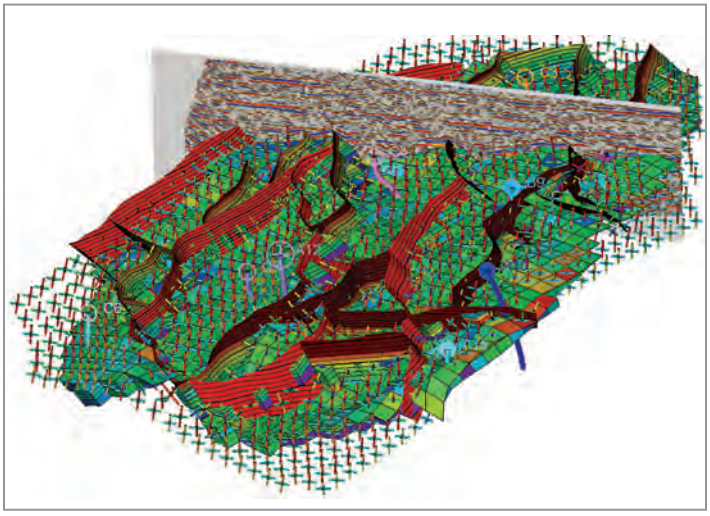
Stress vectors and magnitudes in faulted formation overlying salt.

Versatile workflows

With Petrel Reservoir Geomechanics, you can include multiple data types to create new 3D geomechanics property and stress models, or add geomechanics to enhance existing subsurface models. The seamless workflow in the Petrel platform ensures that the geomechanics model is consistent and integrated with geophysics, geology, and petrophysics information. By coupling the VISAGE simulator to existing models created in the ECLIPSE* industry-reference reservoir simulator, Petrel Reservoir Geomechanics incorporates the time element to extend the geomechanics modeling and analyses to 4D. Reservoir engineers can predict geomechanical effects caused by production scheduling or changes in reservoir pressures, temperatures, and saturations over time.

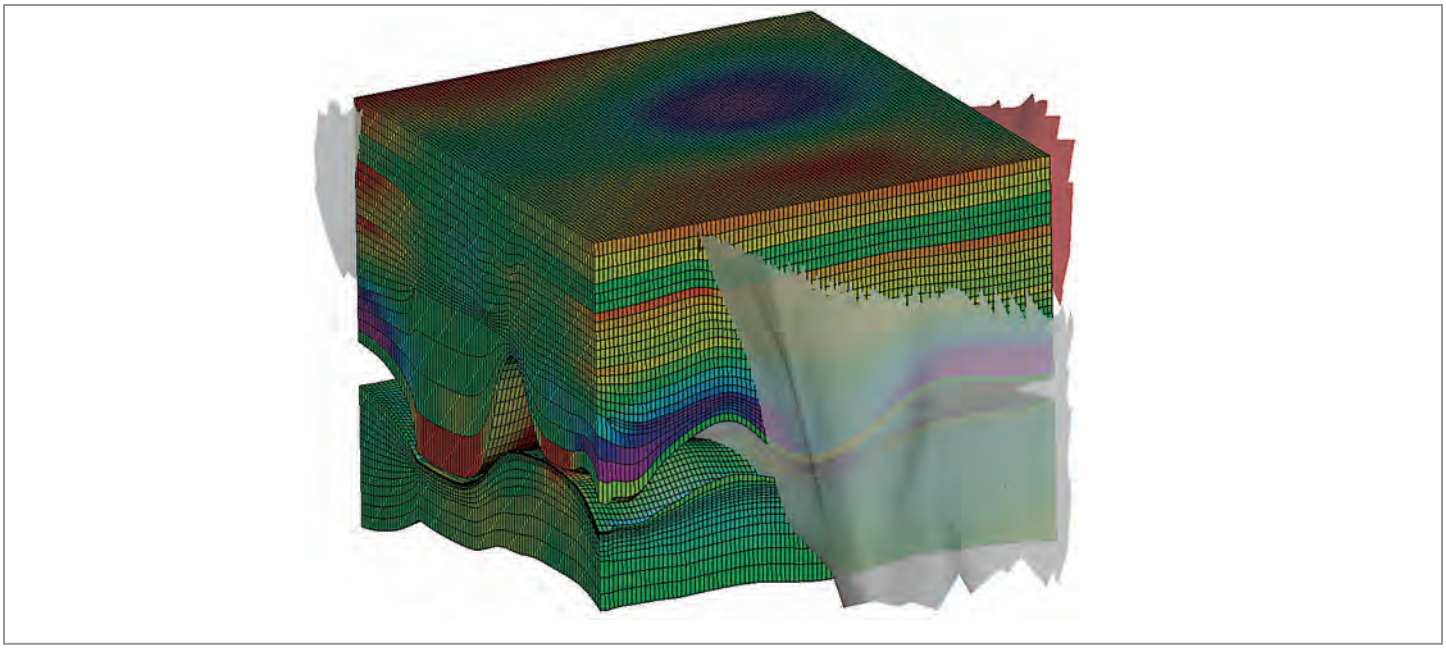
Pre- and postprocessing

Petrel Reservoir Geomechanics provides a robust but intuitive environment for creating or adapting geomechanical simulation grids—they can be built from scratch or migrated from existing reservoir simulation grids for coupled simulations. These grids are populated with geomechanics properties from variety of sources, such as seismic, logs, core, and well test data. The resulting mechanical earth models (MEMs) can be calibrated in the Petrel platform using information from well observations, 4D seismic, microseismic, repeat well logging, and subsidence monitoring.

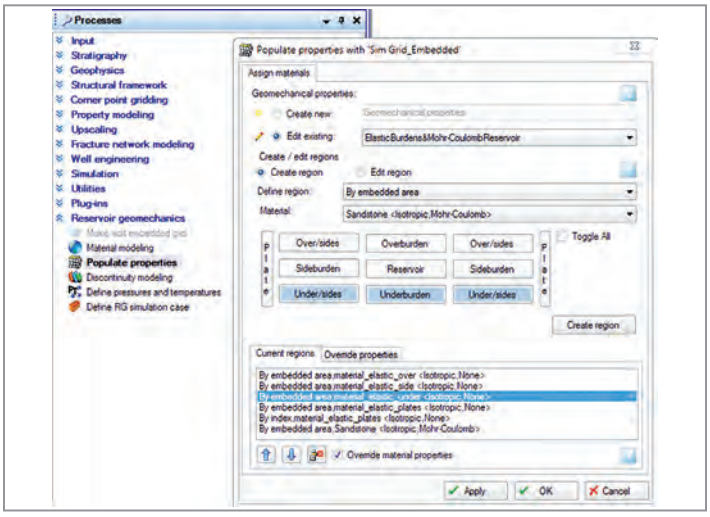


Vectors of total principal stresses at top of a faulted reservoir.

This easy-to-use workflow for initial model building enables users to assign data from various sources (and at varying resolutions) to different regions of the reservoir, including under-, side-, and overburdens. Mechanical properties can also be distributed through different regions of the model using the full range of geostatistical and other techniques available in the Petrel platform.



Effective vertical stresses in rocks over- and underlying multiple salt diapirs.



Dialog window for mechanical property population.

Depending on the data initially available, varying fluids pressures can also be imported and loaded to different regions of the MEM. These data may come from seismic-derived pressure cubes, single-well pressure profiles from trend analyses (such as those conducted using the Techlog* wellbore software platform), or from ECLIPSE reservoir simulations that may provide information on formation pressures that are changing with time and at different locations throughout the life of the asset.

To satisfy different applications and user requirements, the software offers a choice of basic or advanced behavioral modeling and failure criteria—from simple linear elasticity to more complex reservoir behavior models such as nonlinear, anisotropy, and critical state.

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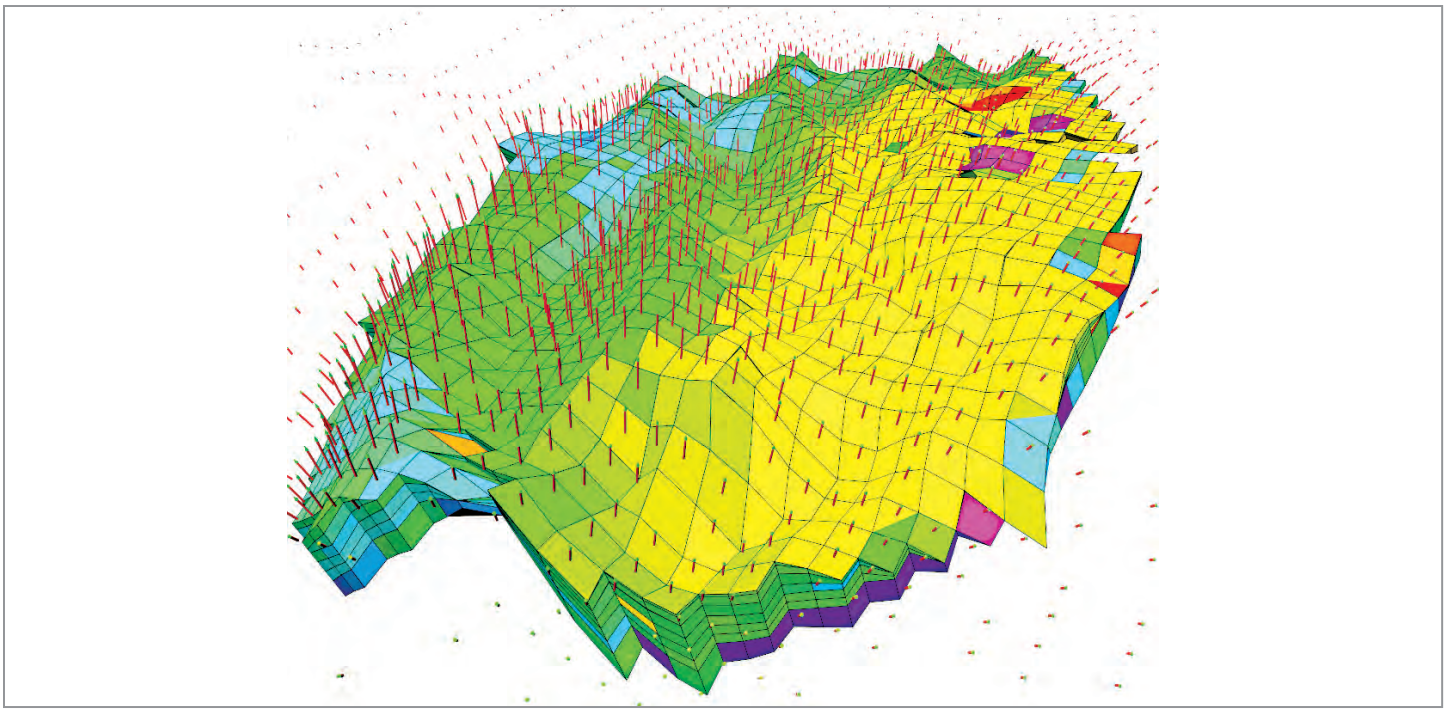

Displacement vectors at the top of a depleting reservoir.

Geomechanics simulation

Having created the initial structural and properties model in Petrel Reservoir Geomechanics, geoscientists and engineers can then submit and control simulations in their familiar Petrel workflow using the advanced VISAGE finite-element geomechanics simulation engine. To complete the MEM, the VISAGE simulator performs the 3D static or 4D flow-, pressure-, and temperature-coupled modeling of rock stress, deformation, and failure data.

This VISAGE output—which can include data for intact or naturally fractured/faulted formations extending to surface—is viewed, interpreted, and checked for quality and consistency in the context of the Petrel project.

For large models, or those coupled to an ECLIPSE reservoir simulation, you can perform parallel simulation runs in the VISAGE simulator using local or remote clusters. The entire process, for single machines or multicore clusters, is managed by the Petrel Reservoir Geomechanics software, meaning the same seamless workflow is maintained in the project from start to end.

Advanced functionality—intuitive interface

Petrel Reservoir Geomechanics has been developed to accommodate different user-profiles and project complexities. It enables specialists from other domains (including geophysics, reservoir engineering, drilling, completions, and stimulation) to incorporate rock stresses, rock displacements, and geomechanics phenomena in their modeling and analyses.

Even with basic input data, a meaningful geomechanics study or sensitivity analysis can be conducted to assess the potential impact of geomechanics, helping to ascertain whether a more detailed geomechanics acquisition and modeling program is necessary.

Workflow and modeling options in the software give geomechanics specialists and expert users a wide range of options to conduct advanced modeling and analyses, or to address specific field engineering challenges. Integrating geomechanics workflows with those from other oilfield disciplines—in the Petrel platform—ensures the geomechanics modeling remains consistent with other subsurface interpretations and models, from petroleum systems modeling to history matching. This increases the quality and validity of both complex and simple geomechanics models, enhancing reservoir characterization, engineering designs, and risk mitigation across a wide range of applications.

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