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Petrel Reservoir Geomechanics

An integrated environment for 3D and 4D geomechanics modeling and simulations

APPLICATIONS

- Assessing and mitigating geomechanical risks
- Optimal well construction and well survivability
- Reservoir performance and integrity
- Underground gas storage, CO_2 disposal, and enhanced oil recovery

BENEFITS

- Improve field characterization and engineering designs
- Understand geomechanical effects throughout the life of the field
- Predict overburden movements
- Perform reservoir, fault, and caprock integrity studies
- Improved ECLIPSE* industry-reference reservoir simulation
- Better stimulation design for unconventionals

FEATURES

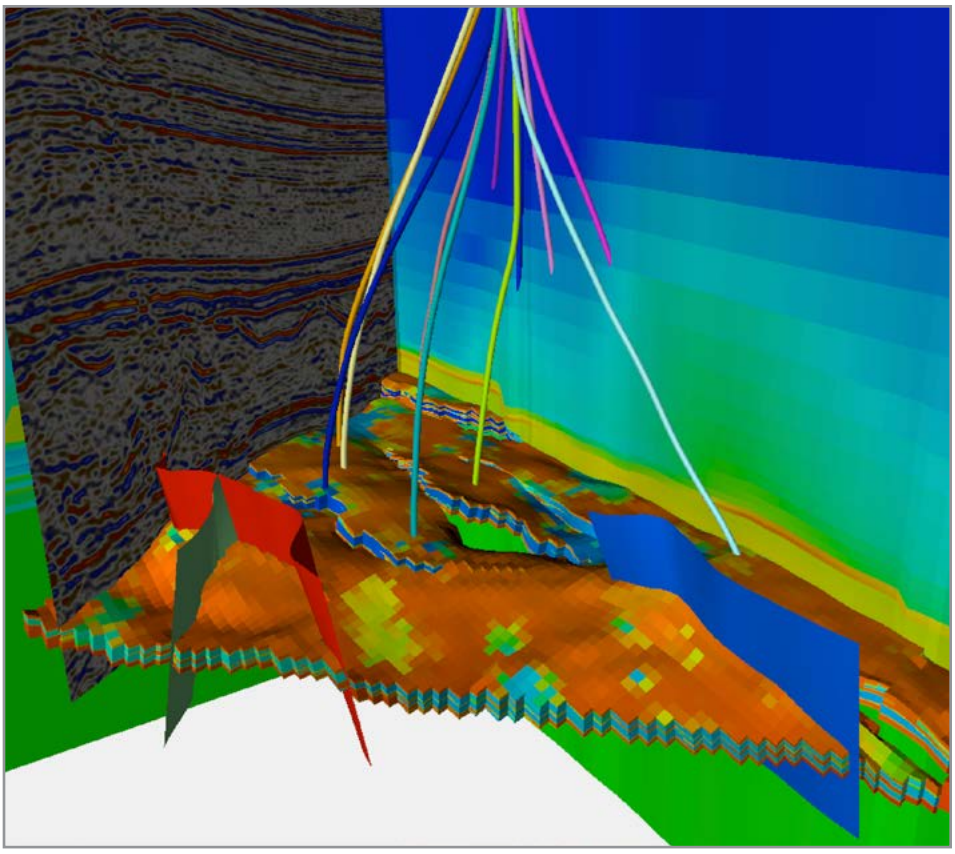
- Incorporates existing reservoir models in the Petrel* E&P software platform
- Modeling of complex structures including multiple faults and fractures
- Local grid refinement (LGRs)
- Exploits GPU and CPU technologies to run faster parallel simulations
- Populate properties from seismic, geological models, logs, cores, and test data
- One-way and two-way coupling with the ECLIPSE simulator
- Supports multimillion-cell models
- Advanced VISAGE* geomechanics simulations within a fully-integrated Petrel platform workflow
- Permeability, porosity, and property updating

The Petrel E&P software platform's reservoir geomechanics module provides an unrivalled environment for 3D preproduction geomechanics modeling and for 4D geomechanics modeling of fields under operation. It enables a comprehensive set of integration, interpretation, modeling, and engineering workflows within the platform, seamlessly powered by the VISAGE finite-element geomechanics simulator.

Geomechanics phenomena such as rock stresses, deformations, and failure have the potential to impact a wide range of oilfield activities from exploration through to development, production, and abandonment. Taking these into account can reduce risk and improve operational and field management decisions for applications such as drilling and completions, well survivability, depletion and injection, and for stimulation and production.

Geomechanics simulations throughout field life

Coupling the 3D models to reservoir simulation incorporates time into the geomechanics modeling, transforming them to 4D. These stresses and movements computed during production (affecting both the reservoir and the surrounding formations up to surface) are used to assess well/completion survivability, potential for solids production, inadvertent loss of reservoir containment and out-of-zone injection, changes in reservoir performance, and environmental impact such as surface subsidence and induced seismicity.



An existing geological model used with full-field geomechanical simulation in the Petrel platform's 3D window.

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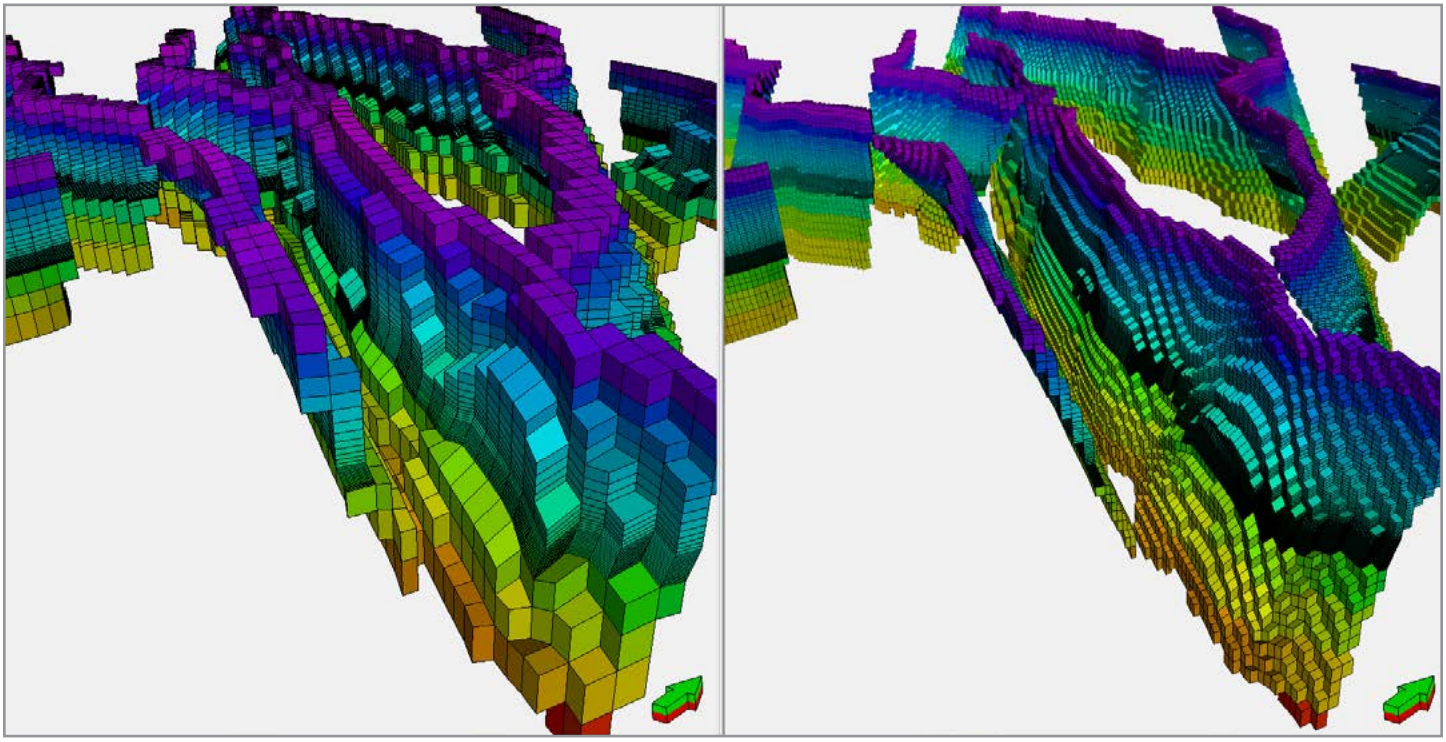

Improved resolution of faults during simulation using LGRs.

Geomechanics model creation and preprocessing

The robust and intuitive environment of the Petrel platform provides users with an end-to-end workflow for creating geomechanical simulation grids within their subsurface models. This permits geomechanics to be included in new models, added to existing models, or used in coupled simulations using models migrated from existing reservoir simulations.

An easy-to-use workflow makes it simple to include or add additional regions of interest and features in the geomechanics analyses, such as over- or side-burdens, horizons, and faults. If required, LGRs can provide increased resolution in the regions of the model around any faults or wells.

Host grids and any LGRs are populated with geomechanics properties from a variety of sources, such as seismic, logs, core, and well test data, or single-well geomechanics models created and validated in the Techlog* wellbore software platform. The full range of geostatistical and other techniques available in the Petrel platform allows users to populate their models with geomechanics properties across selected regions, cell by cell, or with combinations of both.

A choice of basic or advanced rock behavior models and failure criteria are available to satisfy different applications and user requirements. These range from simple linear elasticity to more complex responses such as nonlinear, anisotropy, critical state (modified cam-clay), compaction, and unified models for shear, compaction, creep, and softening in chalks and other weak rocks (including one developed by ISAMGEO Engineering GmbH).

Fracture and fault data from seismic, well logs, or discrete fracture network (DFN) modeling may also be incorporated in the geomechanics model. LGR can provide increased resolution in the regions around faults and wells, and the software is able to handle multiple intersecting faults and DFNs.

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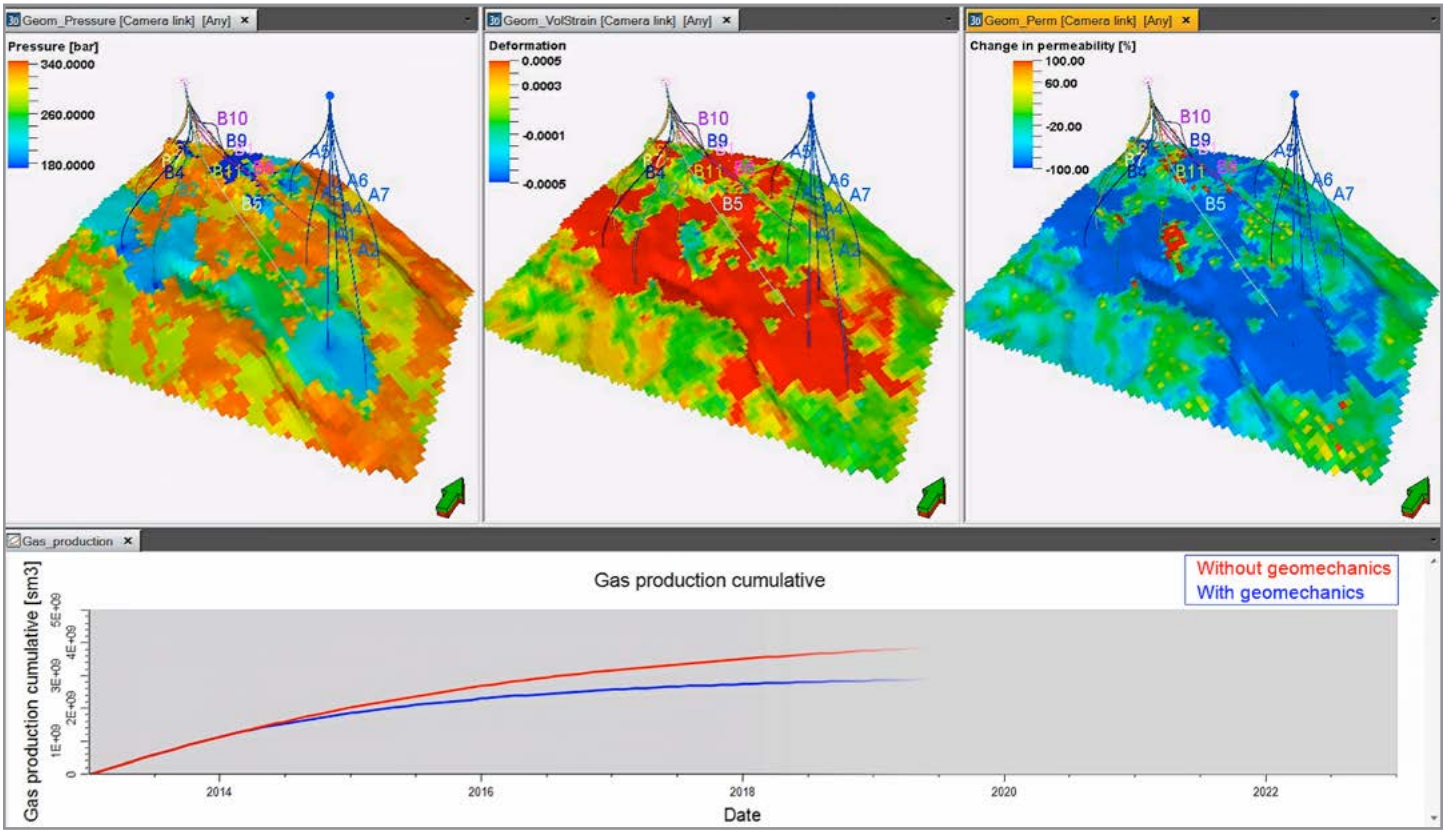

Coupled geomechanics modeling showing effects on reservoir simulation.

Advanced functionality, intuitive interface

The Petrel platform's interface for the powerful VISAGE simulator has been developed to accommodate various user profiles and project complexities. The systematic workflow delivered in a familiar Petrel platform layout makes it easy for specialists from other domains (including geophysics, reservoir engineering, drilling, completions, and stimulation) to incorporate rock stresses, rock displacements, rock failure, and geomechanics phenomena into their modeling and analyses.

At any level of modeling and analysis, the integration of the geomechanics workflows with those from other oilfield disciplines in the Petrel platform ensures that the geomechanics models remain consistent with other subsurface interpretations and models—from petroleum systems modeling at an exploration phase through to history matching in reservoir management and field optimization.

Numerical simulations

The VISAGE simulator performs the 3D static or 4D flow-, pressure-, and temperature-coupled calculations for rock stresses, deformations, and failure. Two-way coupling between the ECLIPSE simulator and the VISAGE simulator allows both permeability and porosity updating of the reservoir model at any selected timesteps, and can update the mechanical properties in the geomechanics model due to effects such as changing temperatures, saturations, stresses, and water softening.

For large models, such as those containing tens of millions of cells, or those coupled to an ECLIPSE reservoir simulation, users are also able to perform parallel geomechanics simulation runs using local or remote CPU clusters. The entire process, for single machines or multicore clusters running Windows or Linux, is managed by the Petrel platform reservoir geomechanics module.

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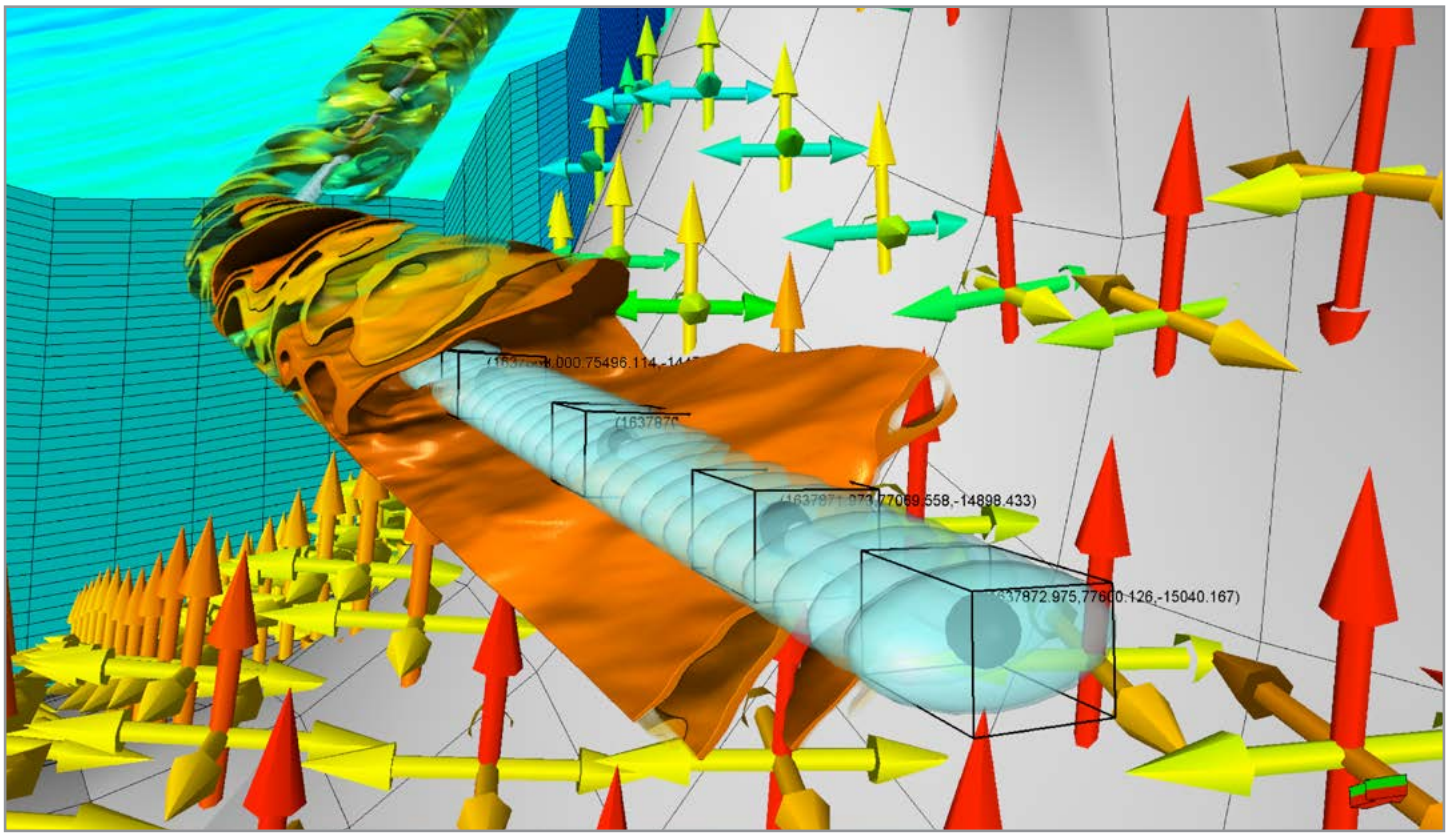

Planning efficient, safer, and more productive wells by taking into account full-field stresses and complete geological context.

Visualization, interpretation, and post processing

The outputs from the numerical calculations may be viewed, interpreted, and checked for quality and consistency in the Petrel platform. These include rock stresses and deformations, failure information, permeability changes, and data for intact or naturally fractured/faulted formations extending to surface.

The VISAGE simulator results and geomechanics models within the Petrel platform are then available for use in further engineering analyses and design workflows focusing on areas such as wellbore stability, optimized drilling and well construction, solids production and completions planning, well survivability, stimulation and EOR projects, field management decisions, and environmental impact assessments.

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