Mangrove
Engineered stimulation design in the Petrel platform

APPLICATIONS
- Conventional and unconventional reservoirs
- Vertical, deviated, and horizontal wells
- Multistage completion design
- Multwell pad optimization

BENEFITS
- Integrates seamlessly with a comprehensive seismic-to-reservoir-simulation workflow
- Enables an engineered approach to completion design, using reservoir characterization for strategic staging and perforation selection
- Models both planar and nonplanar complex fractures accurately
- Accounts for multiwell stress shadow and enables zipper fracture modeling
- Accounts for vertical and lateral rock heterogeneity through 3D geological and geomechanical models
- Provides comprehensive post-treatment evaluation using microseismic data

FEATURES
- Reservoir-, well-, and completion-specific workflows
- Zoned capture of reservoir characterization and structural data
- Multistage completion advisor
- Complex hydraulic fracture models
- High-performance Planar3D* fracturing design simulator based on a planar 3D model
- Structured and unstructured gridding
- Integrated reservoir modeling
- Numerical reservoir simulation
- Side-by-side scenario comparison
- Production forecasting and production history calibration
- State-of-the-art visualization

Mangrove® engineered stimulation design in the Petrel® E&P software platform is the only hydraulic fracturing simulator that integrates seamlessly with a comprehensive seismic-to-simulation workflow in both conventional and unconventional reservoirs. Mangrove stimulation design empowers users to maximize production performance and ROI in tight sands, shale, and conventional reservoirs.

Data-guided zoning
The zoning process provides a wide range of options for accurately capturing reservoir characterization and structural input, supporting enhanced completion design and hydraulic fracture modeling workflows. The zones model can be created from well logs or from 3D models in the Petrel E&P software platform.

Hydraulic fracture simulation
The UFM® unconventional fracture model and the wiremesh model have been specifically developed for simulating nonplanar complex hydraulic fractures in shale reservoirs. Multilayer high-performance Planar3D design simulator fracture simulation engine has also been included in addition to the conventional planar fracture simulators.

Unconventional fracture model
The UFM model is a fully coupled numerical modeling solution capable of simulating complex fracture geometries, while accounting for reservoir heterogeneity, stress anisotropy, and stress shadow effects. It efficiently models hydraulic fracture interactions with natural fractures while solving for fracture propagation mechanics and proppant transport.

Wiremesh model
The wiremesh model, a mathematical representation of the hydraulic fracture network, provides a quick estimate of proppant placement and fracture network dimensions.

Planar3D design simulator model
Powered by high-performance engines, the Planar3D simulator is a full 3D model that creates the most accurate planar fracture simulations in formations with complex stress profiles.
Conventional simulator

The reservoir-centric completion design process uses the reservoir characterization and structural data to provide the best possible completion design. The automated process offers three main reservoir- and well-specific workflows: vertical wells in tight sands, vertical wells in shale, and horizontal wells in shale.

The completion design workflow for vertical wells in tight sands uses pay zones and stress barriers, while the horizontal well workflow uses reservoir quality and completion quality to optimize staging and pinpoint perforation clusters. The completion advisor also provides a limited entry option when intervals with varying in situ stress are stimulated together, ensuring effective stimulation. It offers flexibility similar to the zoning process, maximizing use of available data.

Pressure matching

Mangrove stimulation design workflow supports pressure matching, providing a technique for consistent analysis of pressure records during injection and decline. Changes caused by pump rate and fluid viscosity variations can be taken into account. Models can be calibrated with real pumping data, helping to constrain uncertainty.

It is also used to match simulated and measured fracturing procedures within specified limits. This process uses the prescribed treatment parameters (slurry injection rates, proppant concentration, etc.) to simulate fracturing pressures for a given set of fracture parameters.

Explicit reservoir model gridding

High-resolution simulation grids are automatically generated by explicitly gridding the complex fracture networks while capturing the fracture dimensions and conductivities, as well as tracking the propped and unpropped regions in the networks. Unstructured or structured gridding tools, as appropriate, are used to capture the geology and fracture stimulation impact. Multiple wells can be gridded with explicit definition of the conductivity in each fracture that empowers the reservoir and completion engineers for optimal treatment designs.

Microseismic integration

Integrating microseismic data with reservoir characterization and the advanced fracture modeling of the Mangrove stimulation design supports more detailed analysis in the Petrel platform. Engineers can extract greater value from measurements for a better understanding of stimulation treatments and to improve future treatment designs.

Reservoir simulation

State-of-the-art reservoir simulators complete the workflow. Full numerical reservoir simulations evaluate the quality of the completion design by predicting how much the well will ultimately produce. Multiwell hydraulic fracture gridding and simulation enables studies of well-to-well interference, treatment optimization, and pad optimization. Sensitivity analysis can also be performed, enhancing completion strategy and designs for the wells.

The 3D mechanical earth model shows simulated hydraulic fractures and preexisting natural fractures (orange and cyan planes), together with microseismic data (purple and green dots).