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PetroMod Pore Pressure Prediction

Accurately model compaction and pore pressure from deposition to present day

PetroMod* petroleum systems modeling software combines seismic, well, and geological information to model the evolution of a sedimentary basin. PetroMod software will predict if, and how, a reservoir has been charged with hydrocarbons, including the source and timing of hydrocarbon generation, migration routes, quantities, and hydrocarbon type in the subsurface or at surface conditions.

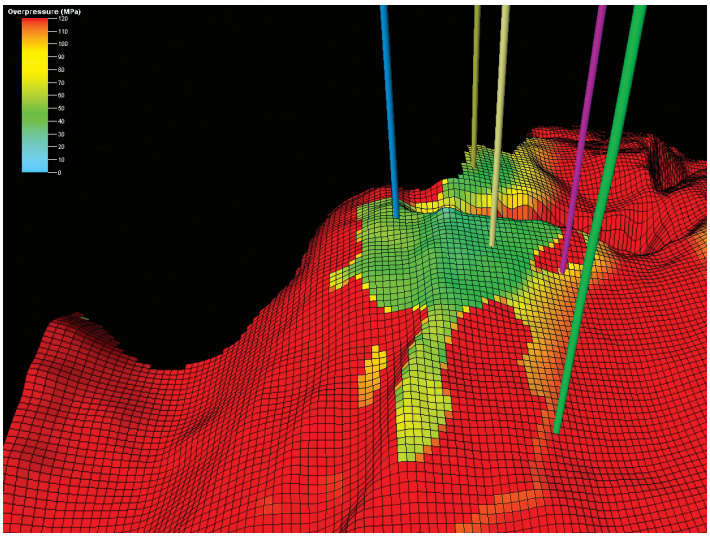
Pore pressure prediction

Pore pressure modeling is part of the PetroMod petroleum systems modeling (PSM) workflow. Results range from a first estimate of overpressured areas—for example, in undrilled frontier areas—up to extremely precise predictions, in which the geometry and facies distribution are well-constrained and the dataset allows calibration to measured pressures. Contrary to geophysical methods, PSM-derived pore pressure prediction does not require seismic velocity information as input; this makes it especially applicable for frontier basins with sparse information. In areas with 3D velocity data, the PSM pore pressure method provides a second, independent prediction that can be compared with other methods.

Pore pressure prediction is used for frontier basins with low data density, using conceptual geological scenarios. It can also be applied to developed prospects in calibrating the pore pressure model to measured pressure data, using refined geometry and facies distribution data, petrophysical properties, and additional data.

PetroMod software and pore pressure

PetroMod software models compaction and pore pressure through geological time, from the deposition of the first layers to present day. The modeling process takes into account time-dependent disequilibrium compaction resulting from high sedimentation rates, undercompaction because of overpressures, and overcompaction resulting from erosion and uplift. The effects of mechanical compaction and overpressure formation are modeled using a Terzaghi-type approach. Secondary pressure effects resulting from cementation of pore space, aquathermal expansion, mineral transformations, and petroleum generation (fluid expansion) can be incorporated into the model.



Overpressure distribution on a reservoir-scale model; high overpressure in rocks with low permeability (red), low overpressure in reservoir rocks (green).

Geomechanics add-on

The Geomechanics add-on improves pore pressure prediction in complex, compressional tectonic scenarios. Geomechanical properties of rocks can be defined in the Lithology Editor—alternatively, use the default values and specify the amount of compression. This add-on enables analysis of the stress and strain distribution in the area of interest and the influence on the pore pressure, including stress tensor visualization and Mohr-cycle analysis in 3D.

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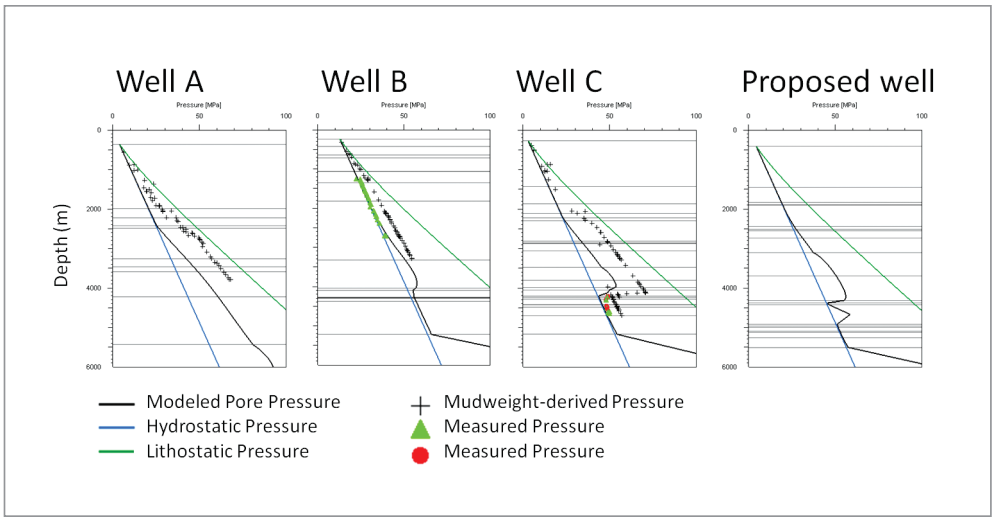

Wells A–C contain calibration data (measured pore pressure and mud-weight–derived pressure) and are from a pressure-calibrated 3D model. The plot on the right shows an extraction from the pore pressure model at a proposed well location.

Benefits of an additional pore pressure model

- Three-dimensional geological model that is consistent with measured pressure
- Calculated pore pressure cube based on typical lithological properties
- Calibrated pore pressure cube that takes measured well and log data into account
- Probability ranges controlled by main model uncertainties
- Derived values such as mud weights, effective stresses, lithostatic stresses, porosities, and bulk densities
- Geological model that can easily be extended to a petroleum systems modeling analysis—with hydrocarbon flow modeling

Required input information

Minimum requirement

- Depth maps of the main surfaces with associated geological ages of deposition
- Bulk facies distribution

Advanced

- Structural surfaces, which can be of different resolution
- Facies distribution maps, such as a geological concept (sequence stratigraphy) or seismic inversion population
- Lithoproperties of facies, including compaction behavior and permeability evolution—with an extensive lithology database to fill gaps
- Calibration data, including measured pressure, log and core measurements of porosity or permeability for lithoproperties, and checkshot velocities
- Faults and related properties (transmissibility)
- Additional information about diagenesis, cementation, and fracturing

Models with complex salt domes

Pore pressure is particularly affected by salt. Reconstruction of the salt layers through geological time is critical for accurate characterization of pore pressure to predict both the presence and quality of hydrocarbons—both simple and sophisticated methods are available.

E-mail petromod@slb.com or contact your local Schlumberger representative to learn more.

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