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Reservoir Modeling - Methodology and Case Studies

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EXTENDED ABSTRACT

Innovative technology together with advanced methodologies are increasing the precision of reservoir modeling used in the development of mature and newly discovered oil and gas fields. GeoSpectrum has conducted several reservoir characterization projects for major oil companies in the last four years, applying sophisticated procedures to describe reservoir architecture. Projects begin with raw subsurface geological data, 3-D seismic data volumes, and engineering/well log analysis data bases. The results of rigorous petrophysical analyses are statistically compared to seismicly derived attributes within the reservoir interval. Significant relationships between reservoir properties and seismic attributes provide the basis for seismicly guided reservoir property maps.

A geologic model is developed and used to recommend a development program. The same model provides data to populate a reservoir simulator for prediction of reserves, economic forecasting, and well pattern design in primary, secondary and tertiary operations. New data (modern log suites, core, etc.) gathered during field development are added to the model to optimize continuing development operations.

The geologic model is built from core description, normalized well log curves, petrophysical analyses, and supporting geophysical data. Contributions from geophysics include: interpreted seismic data, seismic wavelet response to the reservoir rock, and seismicly guided reservoir property maps. Engineering data provides fluid characteristics, rock properties, production history, and derived properties for reservoir simulation.

The microscopic scale...

Core description gives us data on the microscopic scale and assists the team in depth shifting logs to match the core properties. Qualitative logs can be developed to display lithology, rock textures, and pore types (connected vs. unconnected). Thin sections, core analysis data, X-ray diffraction, and SEM analysis can provide additional data to develop transforms between porosity and permeability and to understand the ability of the reservoir to produce economically.

The macroscopic scale...

Log curves provide data on a macroscopic scale and assist the project team in understanding the reservoir rock as measured near the wellbore. Well log measurements collected by different well service companies, under different wellbore conditions, and with different vintages of tools need to be normalized. Normalization can be accomplished using a number of methods, including: a type well approach, using modern log tools, and by applying log curve corrections. Cross plots are often used to invoke the power of statistics to benefit the normalization procedure.

After normalization, petrophysical analysis includes tying the core to the log curves for agreement in depth. If necessary, Vshale corrections can be made to correct logs for the influence of shale. Effective porosity, water saturation, and permeability determinations can be calculated. Again, cross plots play an important role in determining relationships and developing transforms where linear relationships exist. Complex relationships may require more eloquent methods of developing a transform, such as, the use of neural networks.

The megascopic scale...

Geophysics gives us data on an inter-well or megascopic scale. Important steps in the utilization of geophysical data include: the proper acquisition and processing of 3-D seismic data, interpretation, phase analysis (for rotation to zero phase), and the generation of seismic attributes. Geostatistics are then used to determine relationships, if they exist, between the seismic attributes and the petrophysically derived reservoir properties. Statistically significant relationships can be used to generate seismicly guided maps of reservoir properties, such as, porosity and water saturation.

Finally, the results of the geological, petrophysical, and geophysical studies are used to develop a 3-D geologic model with discretely defined flow units or layers. Interpolation of the reservoir properties in three dimensions are output as a grid for use in reservoir simulation.

In conclusion, GeoSpectrum's presentation displays the results of integrated reservoir projects utilizing the above methodology and leading-edge software technology.

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