Paradigm®

TECHNOLOGY FORUM 2017

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Presentation Abstracts

1:35 – 2:05 PM
Quantification of Petrophysical Properties in Thinly Laminated Shaly Sand

Presenter: Brian Lee

Low resistivity and thinly bedded reservoirs often result in under-estimation of hydrocarbon saturation and pay, while with limited data available, finding the best interpretation method that suits your formation can be a challenge. The problems facing petrophysicists interpreting log data from laminated shaly sand formations are not only due to log resolution, but also because conventional resistivity measurements are dominated by high conductivity layers. This means that the majority of the response is due to the shales, while the sand layers containing either hydrocarbon or water will have little effect on the overall measurement.

Tensor petrophysics modeling (by Thomas Stieber) is a log analysis model specifically designed for the evaluation of thin-bedded, low-resistivity sand-shale sequences using vertical resistivity data along with conventional horizontal resistivity data and various porosity and shale indicator methods.

Saturation Height Modeling is resistivity-independent water saturation modeling, which provides free water level and water saturation at the same time. This technique allows real-time interactive manipulation of free water levels in oil-brine and gas-brine systems as well as the gas-oil contact.

2:05 – 2:35 PM
In-situ Stress Analysis in Borehole Image Logs and 1D Geomechanics

Presenter: Brian Lee

The main purpose of a 1D geomechanical analysis is to estimate rock properties and stresses acting on a wellbore, to determine safe mud weight windows and the most stable drilling direction. This particular workflow simulates a post-drilling geomechanical analysis based on data acquired from the well. The results of such an analysis can be used to develop a mechanical earth model (MEM), i.e. define zones with similar rock properties. Once a MEM has been established, it can be used for well planning and pre-drill geomechanical analyses.

The pore pressure is needed to calculate the effective stress acting on each grain of a rock. The effective stress is the difference between the external stress acting on the rock and the internal pore pressure. The pore pressure also defines the lower limit of the mud weight to safely drill a well without formation fluids entering the borehole. Understanding the geomechanical conditions in the formations around a wellbore is essential to ensure well stability or to assess the optimum orientation for fracture development.

Drilling induced fractures - also called tensile fractures - are commonly interpreted alongside breakouts in borehole image logs. The interpreted direction of borehole breakouts and drilling induced fractures indicates regional stress orientation. Both the native stress regime and the fracture density and direction are powerful tools for guiding geomechanical studies.

2:35 – 3:05 PM
Assessing Geomechanical Risks Associated with Hydrocarbon Production

Presenter: Luke van den Brul

Reservoir studies aim at understanding and describing the dynamic behavior of hydrocarbon reservoirs by properly integrating all available geophysical, geological, petrophysical and engineering information, in order to confidently predict the future performance of the field under different development and production strategies. Capturing and preserving the high complexity and heterogeneity that characterize reservoirs is the key starting point for accurate analysis of the geomechanical risks.

These include prediction of reservoir compaction, subsidence, and reservoir stability and safety analysis. As an example, producing hydrocarbons from highly stressed faulted reservoirs, either through primary depletion or enhanced recovery production, can result in unanticipated fault reactivation, leading to potential material impacts, loss of production, or possibly of the reservoir itself.

Enabling the integration of a high fidelity geological model created in SKUA-GOCAD™ with geomechanical simulation opens the door to optimal management of the reservoir and control of production risks. Reservoir Driven Production Risk Management (RDPRM) is a joint solution delivered in partnership with Dassault Systèmes and its geomechanical software Abaqus™.

The combination of these two technologies allows flexibility in the type of mesh used in geomechanical simulation. Its unique value proposition is the accurate determination of fault displacement.

3:20 – 3:50 PM
Integrating Structural and Geological Uncertainties into Reservoir Modeling

Presenter: Luke van den Brul

The resolution of seismic data, substandard quality data or the lack thereof, does not allow us to capture with absolute certainty the location of faults and horizons away from the available control points in the wells. It is typical in today's workflows to study the impact of uncertainties from the point of view of the distribution of the static properties (porosity, permeability) between the wells and the dynamic reservoir parameters (such as relative permeabilities, aquifer parameters, etc.). However, the position of faults and horizons is often fixed to a single realization.

Considering structural uncertainty in SKUA-GOCAD, especially in a complex environment, enables geoscientists to assess the impact of fault position and horizons on rock volumes and estimates of in-place hydrocarbon, and can be brought forward up to production forecasts to improve confidence and reduce risks. The proprietary UVT Transform® algorithm behind the construction of the structural model ensures a representation consistent with the available data for all generated models and the respect of the fault relationships as determined by the geoscientists.

Structural uncertainty can also be combined with geological uncertainties using Jacta® (developed in collaboration with Total E&P) to enable full reservoir volume uncertainty assessment on geologic grids, and quantify uncertainty in the position and volume of hydrocarbon plays.

The results are multiple valid alternatives that can be ranked and exported to commercial flow simulators, summarized for optimal appraisal or infill target identifications, or used to reliably inform traditional Monte Carlo-based economic assessment applications.

3:50 - 4:15 PM
4D QC: Interactive Analysis of Time Lapse Data

Presenter: Karl Hosgood

4D seismic monitoring of a reservoir provides valuable information, including reservoir sweep effectiveness and identification of thief zones, and provides assistance with infill well planning.

However, preparation of 4D datasets presents several problems to the interpreter, such as management of shifts in time, phase and amplitude between monitor surveys. We present a water and CO2 injection case study from Canada that shows use of Paradigm's 4D QC toolkit to quantitatively assess correlativity between monitor surveys and baseline.

The workflow is extended to show how tools such as seismic attribute calculation, multi-attribute rendering, and seismic facies analysis can be employed to further interpret a time lapse dataset.

4:15 – 4:45 PM
Machine Learning Based Lithofacies Prediction in an Integrated Interpretation Canvas

Presenter: Karl Hosgood

Machine Learning is revolutionizing our lives, in areas as disparate as self-driving cars to facial recognition algorithms that now score higher recognition scores than live human viewers. Seismic interpretation is also being altered by machine learning. This presentation describes a workflow using Paradigm’s new Rock Type Classification algorithm, in which a 3D lithofacies volume was created by machine learning applied to a 3D prestack seismic volume. This technology, previously available only as a service, is now a new software offering in Paradigm 2017.

In a few minutes, Rock Type Classification had classified, using facies logs at well locations, a 3D prestack seismic volume, and had returned a 3D volume consisting of rock classes; silicoclastics, bioherm (tight), bioherm (wet), bioherm (oil), limestone, shaly limestone, interbedded, biostrom (tight), biostrom (oil), biostrom (wet). It enabled the user to side-step a traditional QSI (AVO & Inversion) project, which would have taken longer to complete. Rock Type Classification was very easy to use, being fully integrated with the 3D Canvas interpretation workspace; the user doesn’t have to open another application.

Waveform Classification (part of the Stratimagic® product) has also been fully integrated with the 3D Canvas interpretation workspace for Paradigm 2017, making it possible to perform classification while engaged in interpretation, without interruption.

4:45 - 5:00 PM
An Introduction to Paradigm k

Presenter: Luke van den Brul

Traditional design workflows are still hampered by a lack of efficient modeling tools that capture details of the recovery and production process, and work in tandem with G&G modeling tools. Advanced predictive workflows for design and maintenance that honor reservoir physics have been considered too complex, time-consuming and impractical . . . until now.

Paradigm k integrates oilfield data with Production and Reservoir Engineering fundamentals to enrich production datasets and forecast future performance, from the reservoir to the well to the surface. A Cloud-based, collaborative workflow, Paradigm k helps optimize the design and management of well systems. Now you can examine more design cases than ever before, present the best solution, and forecast production with confidence.

After the start of production, Paradigm K collects field data and automatically updates the model to enrich your production dataset and forecast performance in real time. Furthermore, it helps you identify optimal strategies to keep your production on track. Paradigm k provides a single holistic view of enriched production data, and includes Connect (powered by Exigo) for collaboration across organizations and disciplines.

The initial release of Paradigm k has been specifically designed and optimized for shale oil and gas reservoirs. Complex fluid movements around multi-fractured horizontal wells are rigorously simulated: The models are simple to set up and are executed with tremendous speed. Hydraulic fracture models can be oriented and heterogeneous, and include complex structures.

Notes