[PS]Integration Adds Value to Deepwater Oil Exploration and Development: A Case Study of North Gulf of Mexico from Seismic and Well Log to Simulation*

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Abstract

Oil companies acquire all types of data, including well data and seismic data, for oil exploration and development. To maximize the value of the data in addressing the most important of reservoir and field-wide challenges, integration of various data and interpretation is a must. This paper presents a case study of an oil field in the deepwater Gulf of Mexico where all the available data and results, including seismic data, high resolution resistivity borehole images, triaxial induction log, NMR, downhole fluid data, and core data, were carefully and methodically integrated to characterize the reservoir sands. Hemipelagic shale and slumped shale have similar bulk mineralogical compositions and petrophysical properties, they were distinguished based on textures from the borehole images and heterogeneity analyses from triaxial induction logs. Based on dips from borehole images, paleo flow directions of reservoir sands were defined. A relationship between lithofacies and a relative acoustic impedance (RAI) volume was established; and the lithofacies defined from wellbore data were populated into the 3D space guided by the RAI volume. The integrated study suggests the main reservoir of the field is a system of submarine lobe sands deposited above allochthonous salt in a mini basin. The lobe system concept was used in reservoir simulation. Both seismic isopach image analysis and DFA analysis indicate good lateral connectivity with limited vertical connectivity across the shale break. An erosional surface is posited as a possible shale pinchout establishing connectivity between upper and lower sands. The corresponding geologic model with populated facies and properties (porosity, permeability and water saturation) provided a basis for a reservoir simulation model to demonstrate hydrocarbon-in-place and reservoir connectivity. A geobody extracted from seismic acoustic impedance (AI) helped to understand the reservoir performance. The model was validated by 1.5 years production and pressure data. The case study presented illustrates the role of coherent integration of diverse data to build robust models for history matching and simulation to guide field management and development decisions.

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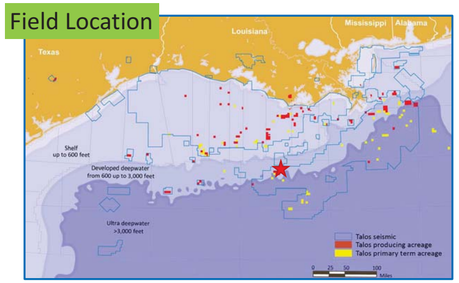
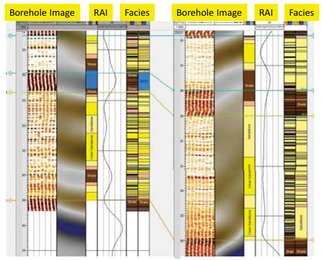
Field Location

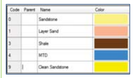


(From Talos Energy Website, 2019)

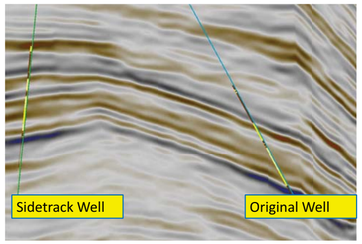
Integrate logs into lithofacies



Lithofacies is interpreted with high resolution borehole images, petrophysical logs and seismic data.

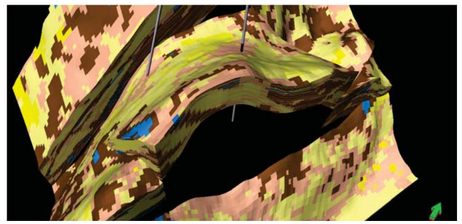


Integrate lithofacies with seismic



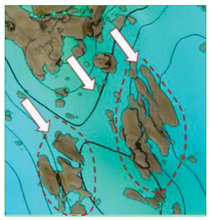
Comparison of lithofacies and seismic data (Relative Acoustic Impedance) established a good relationship between lithofacies and seismic data.

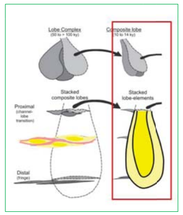
Populate lithofacies into 3D based on seismic



Based on the relationship between lithofacies defined on wellbores and the seismic data, lithofacies was populated into 3D.

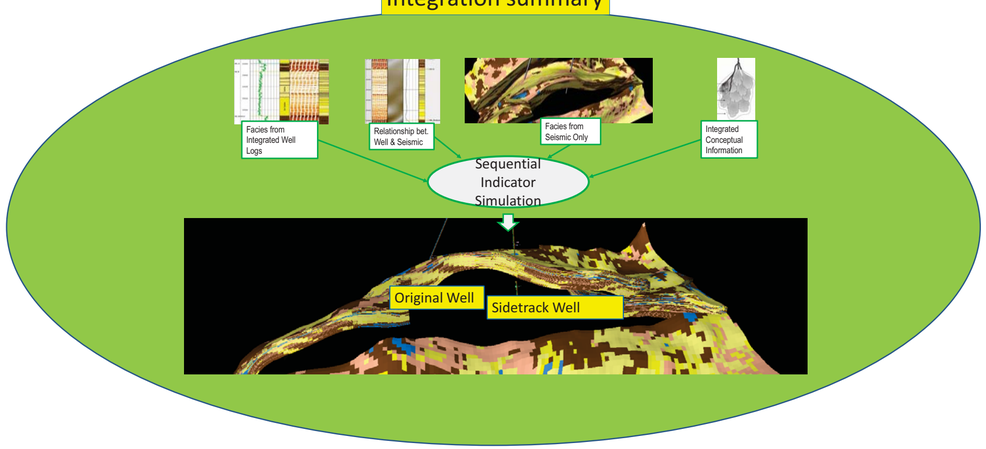
Integrated depositional model



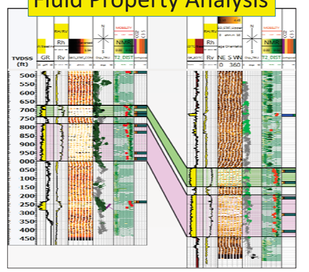


Geobodies defined based on seismic attribute (relative acoustic impedance) mimics individual sand lobes. They are interpreted as spill-over sands from the mini basin where the main reservoir resides. A depositional model of lobe sands is proposed for further lithofacies modeling.

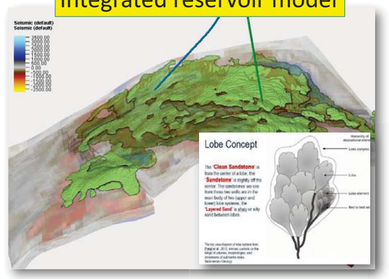
Integration summary



Fluid Property Analysis

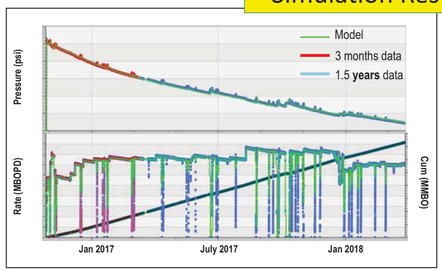


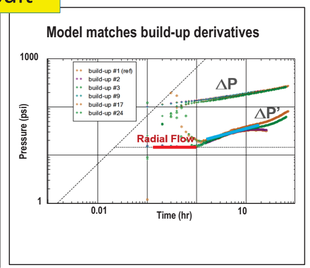
Integrated reservoir model



Dynamic fluid analysis results and a geobody concept were incorporated into reservoir simulation.

Simulation Result





Reservoir simulation results match the history of the field in both production and pressure for 3 month initially, and extended 1.5 years later.

Conclusions:

1) Log data from the wellbore correlates the seismic data very well, thus increased the confidence of the interpretation.
2) Integration improved understanding of the sedimentary process and the reservoir and production dynamics.
3) The results of this study provides an important basis for field management and development decisions.
4) Integration added value to field development.

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