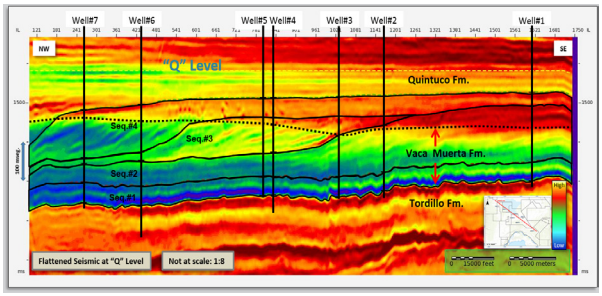
A Sequences Characterization Workflow in a Core Exploration Area, Vaca Muerta System, Neuquén Basin, Argentina

RESULTS

- A multi-disciplinary interpretation workflow resulted in the description of four second order sequences in the Vaca Muerta formation, each described in terms of its own architecture, depositional pattern style, internal litho-stratigraphic configuration and seismic signature.
- After defining the stratigraphic sequence correlated with the seismic attributes, it was possible to create a model that matched the geological, well core and production data.



▲ *Acoustic impedance cross section showing sequence distribution in the Vaca Muerta System in the study area. Note the high impedance values towards the top of Sequences #2, #3 and #4 and the low impedance values towards the bottom.*

APPLICATIONS

SeisEarth™ multi-survey, regional-to-prospect interpretation system

CUSTOMER

YPF S.A.

CHALLENGE

The Vaca Muerta Formation was deposited in the Neuquén Basin, located in the west-central part of Argentina. It comprises a rock unit with high values of TOC, so it holds great potential as an unconventional shale gas and oil resource play. Together with the Quintuco Formation, it forms a highly geologically complex system, due to its large size and extension.

"For over five years, I have used SeisEarth to perform a wide variety of interpretation tasks, including attribute calculation, opacity visualization, multi-3D seismic merge, well path design, flattening, horizon slices, multisurvey visualization, and color palette manipulation. Use of SeisEarth has led to important advances in the exploration of unconventional plays in Argentina."

David Guerberoff, YPF Geophysicist

Like other unconventional resources, the most challenging aspect of developing Vaca Muerta is to optimize the drilling strategy to improve hydrocarbon production, which goes hand in hand with an efficient geological sequence description. Thus, the aim of this study was to characterize the Vaca Muerta system and improve our understanding of the reservoir's characteristics.

SOLUTION

Due to the significant scale heterogeneity of the available data in the area of study, it was necessary to adopt a scalable and multidisciplinary approach, with the goal of integrating sub-millimetric thin sections, seismic data, cores and well logs.

The YPF geoscientists used the Paradigm® SeisEarth® multi-survey, regional-to-prospect interpretation system to perform detailed, multi-scale, structural and stratigraphic interpretation from a very large dataset. Seismic interpretation was performed on reflection data and reservoir property attributes. It was then correlated with well logs through crossplots, validating the interpretation of well logs with thin sections of core data and cuttings.

All automated and semi-automated processes for interpreting seismic data were easily applied, delivering high quality results within a short period of time.

To reveal the characteristics of the seismic data, the following SeisEarth capabilities were utilized:

- Fast data mining through gathering all data in one dynamic canvas
- A sophisticated 3D environment allowing high-quality display for detailed seismic interpretation
- Interactive work with an unlimited number of attributes; advanced merge options and high-quality rendering through opacity enabled easy adjustment of each attribute
- An advanced interface for high-performance management of routine tasks when working with seismic attributes and seismic interpretation

RESULTS

This multi-disciplinary interpretation workflow resulted in the description of four second order sequences in the Vaca Muerta formation; each was described in terms of its own architecture, depositional pattern style, internal litho-stratigraphic configuration and seismic signature.

This result was enabled by simultaneously interpreting different types of seismic attributes using interpretation techniques enabled by the SeisEarth environment. Based on this approach, acoustic impedance was a determining attribute in individualizing the different sequences: Sequence #1 was associated with predominantly low values, while there was a graduation from high to low in Sequences #2 and #3. Sequence #4 was mainly defined by high values of acoustic impedance.

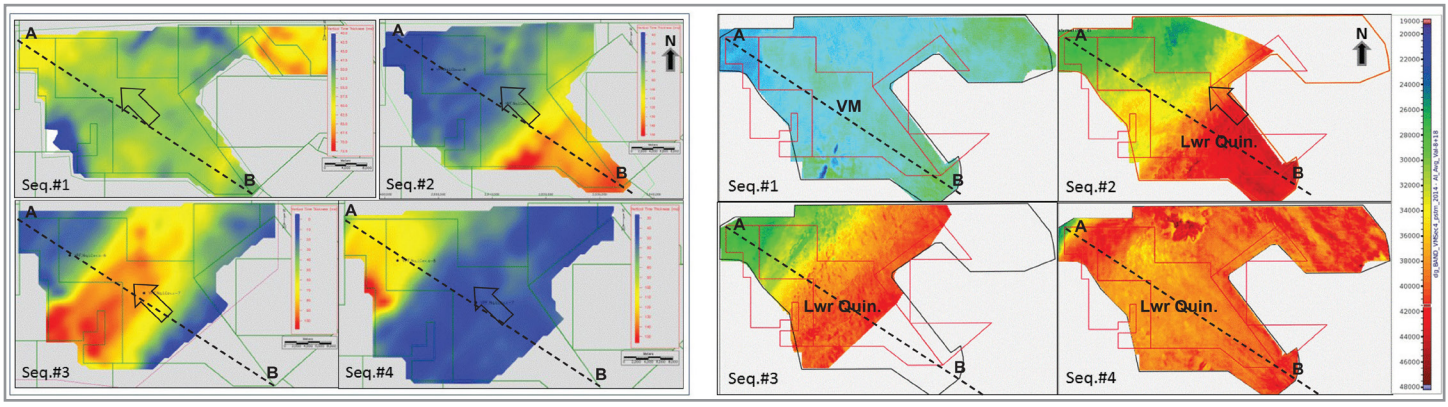
After defining the stratigraphic sequence correlated with the seismic attributes, it was possible to create a model that matched the geological, well core and production data.

These sequences are now being used by the exploration team to improve the location of future appraisal wells and to prepare development plans. The next step will be to perform correlation of a vertical succession of lithofacies with seismic facies. This will allow the team to define sweet spots in a predictable volumetric distribution, helping them to improve their development strategy.

BENEFITS

The strength of this technology is its ability to integrate facies of different origins and types (well and seismic data) and resolutions into a single geologic model. This study showed the potential of seismic data reliability for characterizing facies distribution in a complex geologic environment. It also proved the sequence stratigraphic conceptual model associated with the confirmation of new potential areas.

Based on these results, the YPF geoscientist was able to confirm her theory regarding the reservoir lithology in a specific area of the field, and gain a better understanding of the geologic settings of the play. She was then able to launch an investigation into potential plays outside of the main structure and propose new wells.



▲ *Sequences distribution in the area. Left: thickness map - arrows indicate flow direction. Right: acoustic impedance value extraction from the top of each sequence*

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