YPF

Seismic Classification and Modeling Solutions Enhance Understanding of the Geology for Optimized Drilling

aspentech | Case Study

"Calibrating seismic facies with well logs and core are helping us to optimize the placement of future wells, identify new plays and reduce risks."

Veronica Hammar, Geologist, YPF

Key to this technology is the integration of different origins, types and resolutions into a single geologic model.

CHALLENGE

Accurately delineate stratigraphic features in a formation, to gain a better understanding of the geologic setting before deciding on placement of future wells.

SOLUTION

The Aspen SKUA™ subsurface modeling solution was selected to visualize well and seismic data and interpret vintage 2D and new 3D seismic data, report on geothermal reservoirs and create structural models.

VALUE CREATED

- A better understanding of the geologic settings, significantly impacting well drilling optimization.
- With the gained knowledge, customer identified potential plays outside of the main structure and proposed new wells.

Overview

YPF S.A. is a majority state-owned Argentinian energy company and a key user of AspenTech Subsurface Science and Engineering Solutions in South America. In a tight gas field in the Neuquén Basin in Argentina (part of a complex delta front system known as Lajas Formation [Figure 1]), the company was challenged to map facies distribution in a targeted formation in order to more accurately delineate stratigraphic features.

Because most of the wells are spatially close to the top of the anticline structure, seismic is the only data available for constraining the deposition model and facies distribution away from the wells. Although it's possible to define a linear trend between acoustic impedance volumes and facies from wireline logs and core data, it is still difficult to define cut off values to clearly separate facies in such a heterogenous sedimentation (Figure 2).

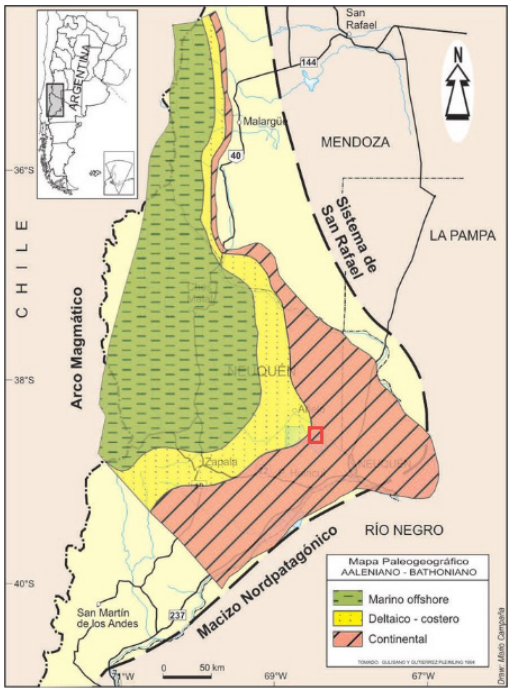

Figure 1: Basin and field location (from Arregui et al, 2011).

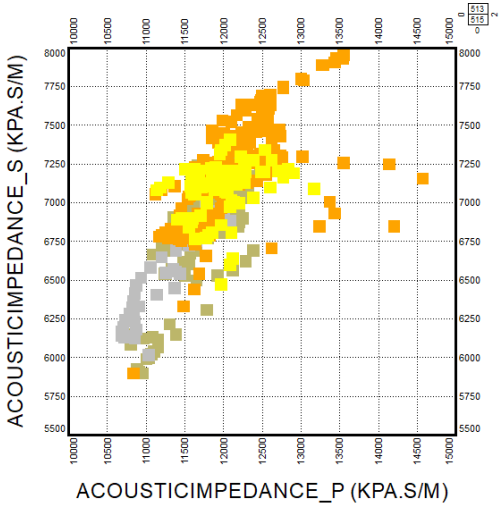

Figure 2. Crossplot between impedance logs of one well colored by facies described on core data of Lajas Formation. Cut off impedance values for each facies are not clear.

Seismic Classification for More Accurate, Efficient Analysis

In order to perform the analysis with maximum accuracy and efficiency, the powerful and well-proven SeisEarth™ seismic classification solution was used to map the lithology distribution, obtained by electrofacies characterization from well data.

The workflow was divided into 3 stages:

1. Unsupervised multi-attribute seismic facies classification
2. Geologic modeling
3. Calculation of probability volumes of occurrence for each electrofacies

Automated seismic facies classification is an important technique in the stratigraphic interpretation of seismic data, potentially playing a significant role in characterizing the field. An unsupervised multi-attribute seismic facies classification, based on neural network technology, was applied to a set of poststack attributes representing the reservoir's elastic properties: P-wave and S-wave impedance. A sample-based classification was applied, and the output was a volume describing the seismic facies distribution for a fixed number of classes (11 in this study).

Honoring a seismic interpretation based on sequence stratigraphy concepts, a 3D structural model was built using the Aspen SKUA volume-based modeling technology. The resulting geologic model comprised progradations, aggradations and retrogradations of strata inside the Lajas Formation, as well as maximum flooding (MFS) and sequence boundary (SB) surfaces. All of the terminations presented in the geologic model, such as onlaps, toplaps, downlaps and erosional truncations, were truly represented in the geocellular grid (Figure 3).

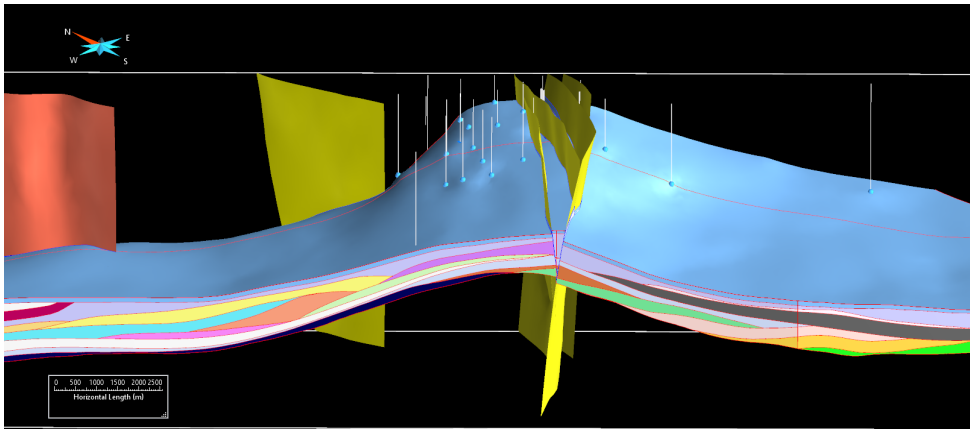

Figure 3. Geologic grid built of 24 horizon interpretations. Close up of strata terminations such as onlap, downlap and erosional truncations.

To better constrain the facies distribution away from boreholes, well data and the result of the unsupervised multi-attribute seismic facies classification were analyzed together. First, to control the relationship between facies from wells and seismic, it was necessary to upscale the electrofacies to a coarser resolution. Then, 3D data and trend analysis were performed: For each seismic facies, the algorithm counted the collocated well facies samples and calculated the probability of occurrence within each seismic facies. The result is shown in a calibration histogram containing all electrofacies versus seismic facies (Figure 4). 3D probability volumes for each facies were generated to be used as a 3D trend in simulating the facies (Figure 5).

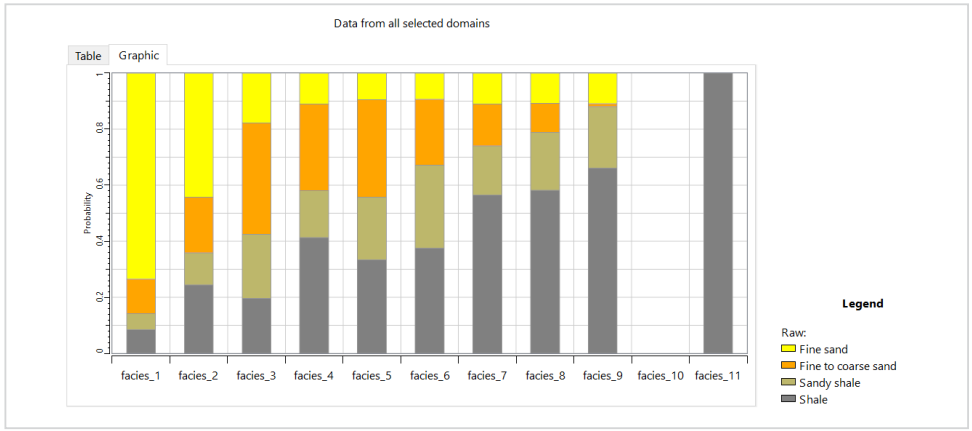

Figure 4. Calibration chart showing the presence of each electrofacies inside the seismic facies.

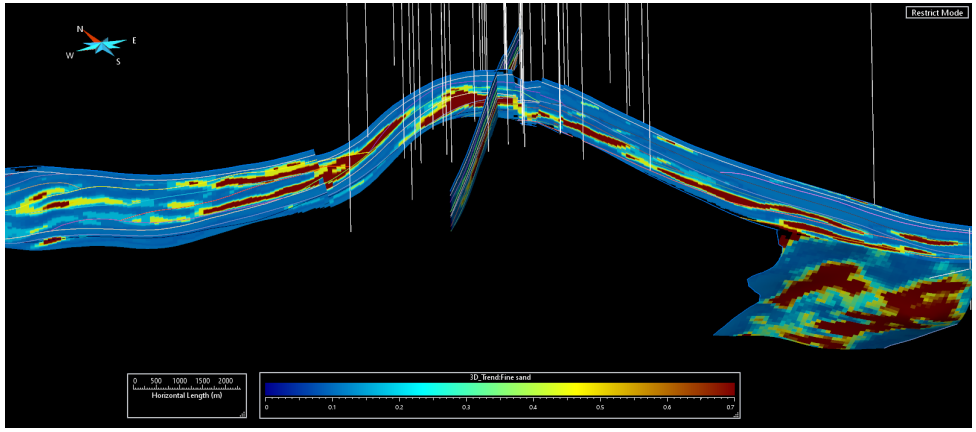

Figure 5. Probability volume for the occurrence of fine sand facies.

Improved Correlation and Single Model Integration of Facies

By using the neural network method in an integrated approach, the YPF geoscientist was able to classify the attribute response of elastic properties and obtain a clear description of the seismic facies distribution, for better correlation with scattered well facies. Computed probability volumes for each electrofacies succeeded in constraining electrofacies distribution based on their correlation with the seismic facies (Figure 6), respecting the complexity of the structural and stratigraphic geo-cellular model and enabling the estimation of net thickness maps for the lithologies of interest (Figure 7).

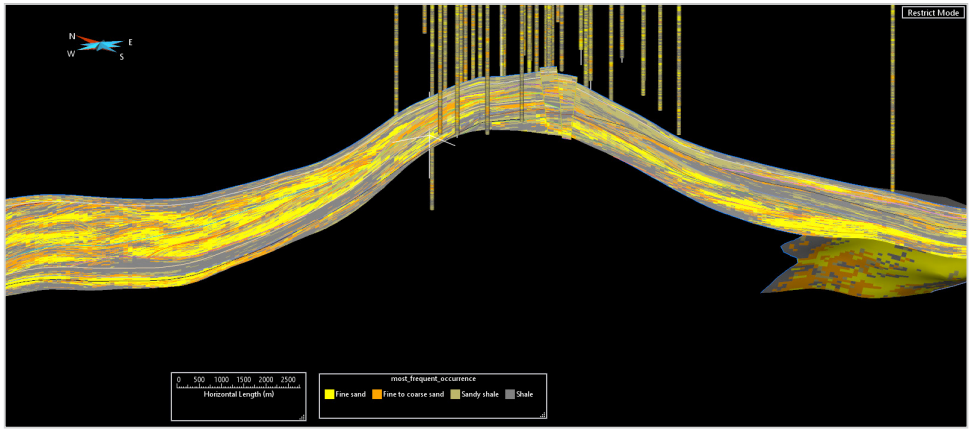

Figure 6. Most frequent occurrence of simulated facies using probability volumes as a 3D trend.

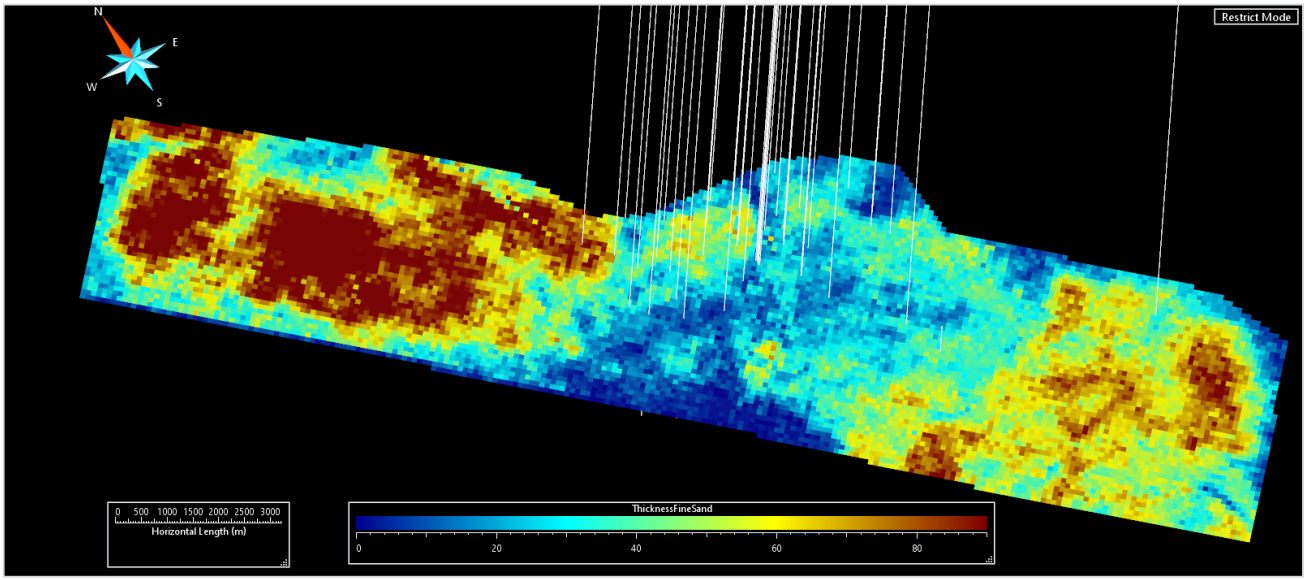

Figure 7. Thickness map of just one reservoir lithology, fine sand, with strong presence away from the wells. In the main structure the thickness of this lithology is around 50m in produced wells.

Conclusion

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.

About Aspen Technology

Aspen Technology (AspenTech) is a leading software supplier for optimizing asset performance. Our products thrive in complex, industrial environments where it is critical to optimize the asset design, operation and maintenance lifecycle. AspenTech uniquely combines decades of process modeling expertise with machine learning. Our purpose-built software platform automates knowledge work and builds sustainable competitive advantage by delivering high returns over the entire asset lifecycle. As a result, companies in capital-intensive industries can maximize uptime and push the limits of performance, running their assets safer, greener, longer and faster.

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