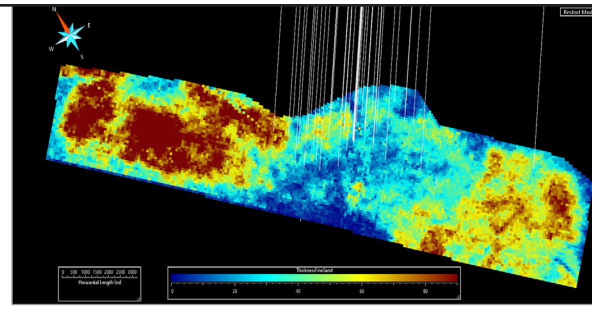
Emerson Seismic Classification and Modeling Solutions Enhance Understanding of the Geology, to Optimize Drilling

RESULTS

- By combining a neural network-based seismic facies classification with a volume-based modeling solution, the customer's geoscientist was able to obtain a clear lateral and vertical discrimination of the lithology, correlated with the scattered well facies.
- The geoscientist gained a better understanding of the geologic settings, with potential upside areas enhanced outside of the main structure. This information had a significant impact on well drilling optimization.



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.

APPLICATIONS

Stratimagic™ Seismic Classification
SKUA-GOCAD™ Subsurface Modeling

CUSTOMER

YPF S.A.

CHALLENGE

Located in the Neuquén Basin in Argentina, this tight gas field is part of a complex delta front system known as Lajas Formation (Figure 1). 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's still difficult to define cut off values to clearly separate facies in such a heterogenous sedimentation (Figure 2).

The challenge for YPF S.A., a major Argentinian energy company and a key user of Emerson solutions in South America, was to map the facies distribution within the targeted formation to delineate stratigraphic features more accurately. Reservoir facies consist of fine and fine-to-coarse sand.

SOLUTION

In order to perform the analysis with maximum accuracy and efficiency, the powerful and well-proven Stratimagic seismic classification solution from Emerson 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, and 3) calculation of probability volumes of occurrence for each electrofacies.
Automated seismic facies classification is an important technique

> ***"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**

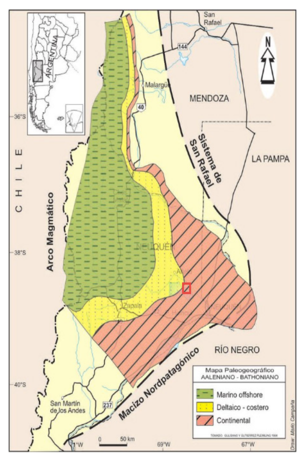


Figure 1 : Basin and field location (from Arregui et al, 2011)

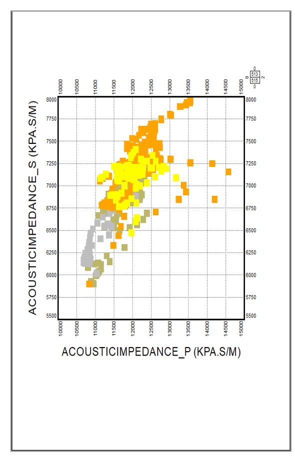


Figure 2. Crossplot between impedance logs of one well colored by facies described on core data of Lajas Formation. Cut off impedance values for each facies are not clear.

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 Emerson SKUA-GOCAD™ 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).

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).

RESULTS

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.

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.

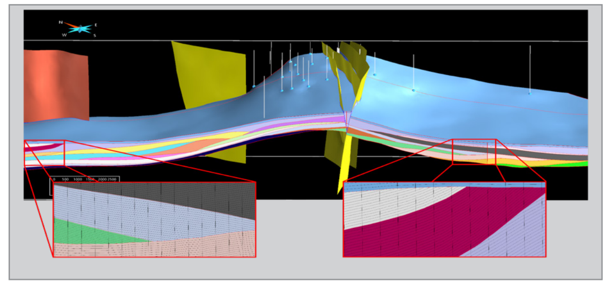


Figure 3. Geologic grid built of 24 horizon interpretations. Close up of strata terminations such as onlap, downlap and erosional truncations.

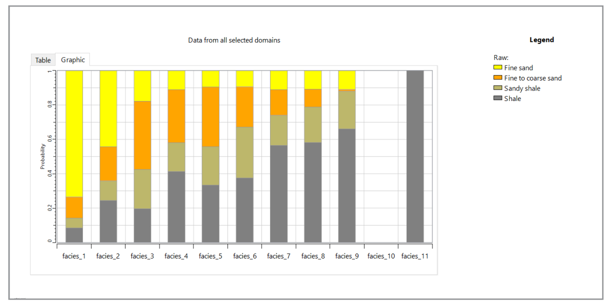


Figure 4: Calibration chart showing the presence of each electrofacies inside the seismic facies.

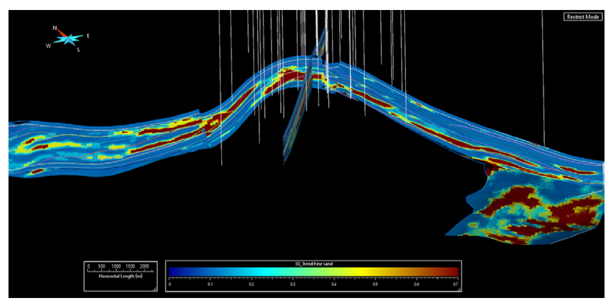


Figure 5: Probability volume for the occurrence of fine sand facies.

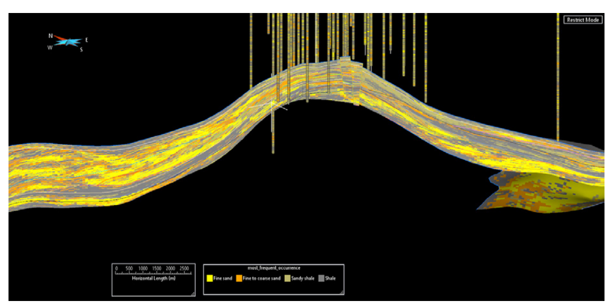


Figure 6. Most frequent occurrence of simulated facies using probability volumes as a 3D trend.

Emerson E&P Software
Two Memorial Plaza
820 Gessner, Suite 400
Houston, TX 77024
T +1 713 393 4800

Emerson E&P Software

For more information:
www.Emerson.com/EPsoftware

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