AspenTech Solutions Combined with Machine Learning Help Reduce Geological Risk During Well Planning and Drilling

aspentech | Case Study

> "Geolog allowed us to quickly and qualitatively assess variations in facies zoning and saturation patterns. This helped us predict the filtration capacity properties of sediments at a distance from the well, enabling us to select the optimal location for well placement."

Customer's Key Specialist

CHALLENGE

Due to high lithofacies variability and uncertainties in the position of water-oil contact levels of a field in a major development project, a customer in Eastern Europe needed a more accurate assessment of effective oil-saturated thicknesses.

SOLUTION

New, modern machine learning-based algorithms were used to analyze complex borehole and seismic studies. A set of unique classification approaches embedded in Aspen SeisEarth™ and Aspen Geolog Facimage™ software allowed better identification and detailing of prospects.

VALUE CREATED

- An integrated analysis of multi-scale geological, geophysical and seismic information using machine learning provided a reliable prediction of facies identified from well data.
- Enhanced interpretation accuracy helped specify promising zones and increased oil saturation.
- The customer was able to reduce geological risk during subsequent well placement.

Overview

A successful strategy for the development of an oil field requires a thorough understanding of the geological structure of its main reservoirs. As the area is drilled, the goal is to clarify the structure of the hydrocarbon deposit, but in the case of a complex structure of the pore space of reservoirs and lithological heterogeneity over the area, geological uncertainties and risks for subsequent well placement remain high.

A major challenge in producing hydrocarbons is predicting rock types and the distribution of fluid content throughout the reservoir away from wells. The determination of rock properties is the main source of uncertainty in reservoir modeling studies.

A client in Eastern Europe encountered problems like the ones described above in one of its main development projects. The productive zones in the studied horizon were mainly confined to thin bed, low-pore reservoirs with a complex structure of pore space. Furthermore, in the central area of the field, where extensive drilling had taken place, oil-saturated reservoirs were mainly found within the target horizon, while the marginal areas of the field, complicated by reservoir caps and several hydrodynamically isolated deposits, had not been sufficiently studied and were of great interest in terms of prospects.

Due to high lithofacies variability and the presence of uncertainties in the position of the water-oil contact levels of the field, there was a need for a more accurate assessment of the effective oil-saturated thicknesses.

Classical algorithms exist for solving these problems, and petroelastic modeling, fluid substitution by Gassmann and seismic inversion were performed in response to this challenge (Figure 1). However, due to the limitations of these approaches, it was impossible to predict the distribution of oil-saturated reservoirs and their separation from water-saturated reservoirs using AVO inversion in the work area. Even for large effective reservoir thicknesses, it was impossible to estimate the saturation pattern in wave seismic fields.

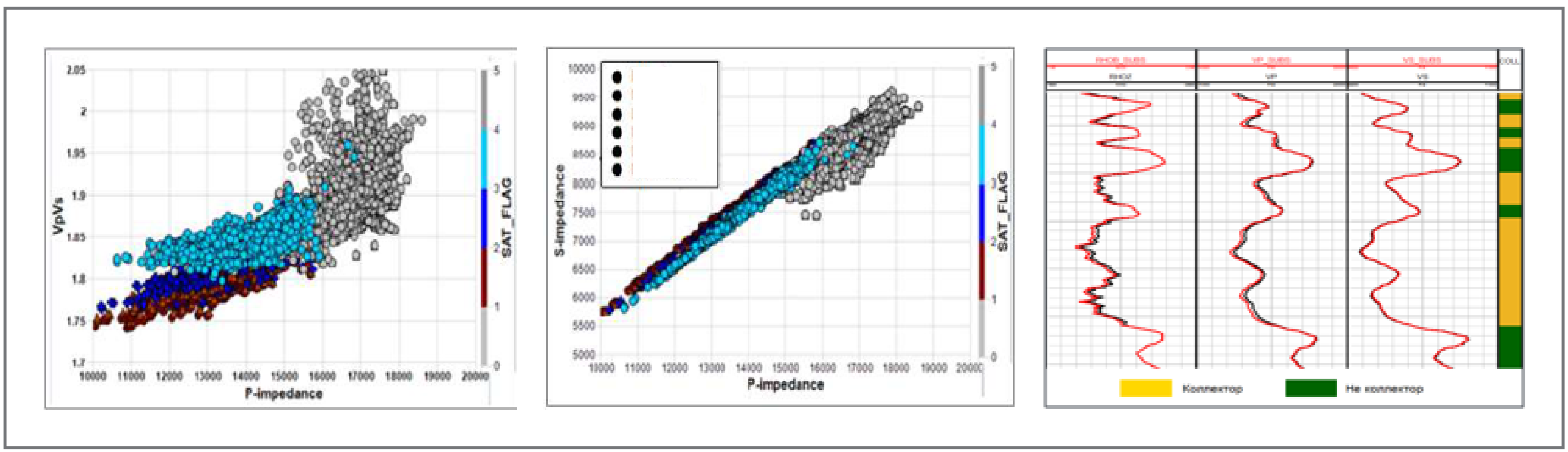

Figure 1. Limitations of the classical approach.

Unique Classification Approaches Allow Better Identification of Prospects

New, modern, machine learning-based algorithms were used to analyze complex borehole and seismic studies. A multidisciplinary team of specialists comprising petrophysicists, geologists and geophysicists from both the supplier and the client, was created to perform a comprehensive analysis of multi-scale geological and geophysical information.

The project used a set of unique classification approaches embedded in Aspen SeisEarth and Aspen Geolog Facimage software, which allow better identification and detailing of prospects. Facimage Multi-resolution Graph-based Clustering (MRGC) technology was applied to perform lithofacies analysis and saturation character prediction using well data, including wireline logs, core data and well testing data (Figure 2). The Democratic Association of Neural Networks (DNNA) algorithm was used to propagate electrofacies in the inter-well space, obtaining lithofacies cubes and ascertaining the probability of the existence of each facies.

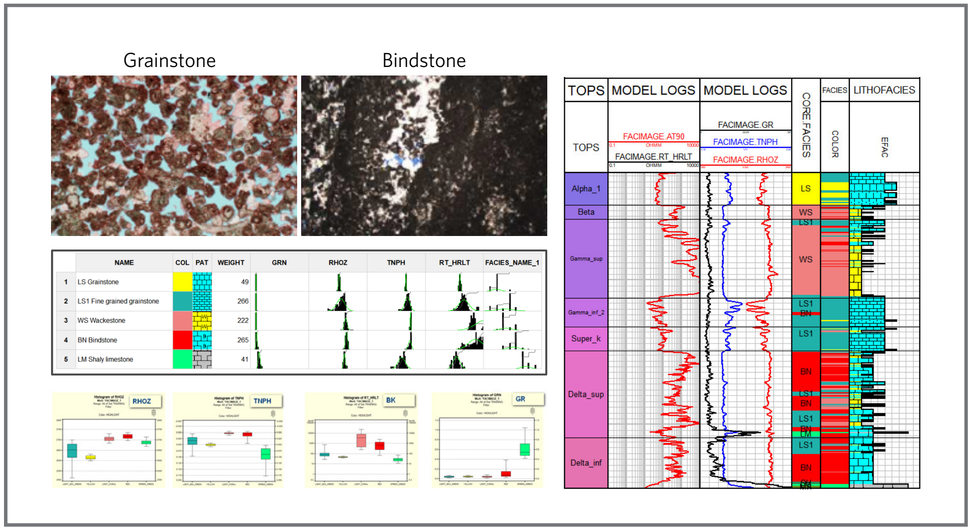

Figure 2. Facimage Multi-resolution Graph-based Clustering (MRGC) technology applied to lithofacies analysis and saturation character prediction using well data.

Results

The use of machine learning methods not only enabled identification of the main lithotypes, it also improved the forecast of permeability by clarifying the dependencies for each group of lithotypes. Using various dependencies for the selected facies groups led to a better convergence of the predicted permeability values using wireline and hydrodynamic logging data (Figure 3). Adding resistivity logs and the results of well testing to the training data made it possible to predict the type and quality of the reservoir layer saturation.

Applying the interpretation results and machine learning methods in seismic construction showed the distribution of the expected type of saturation over the area. The results of this methodology converged well with current understanding of reserves distribution and served as a complementary tool for confirming the accuracy of additional exploratory well placement (Figure 4).

The neural network approach enabled configuration of complex nonlinear dependencies, that are not available using conventional methods.

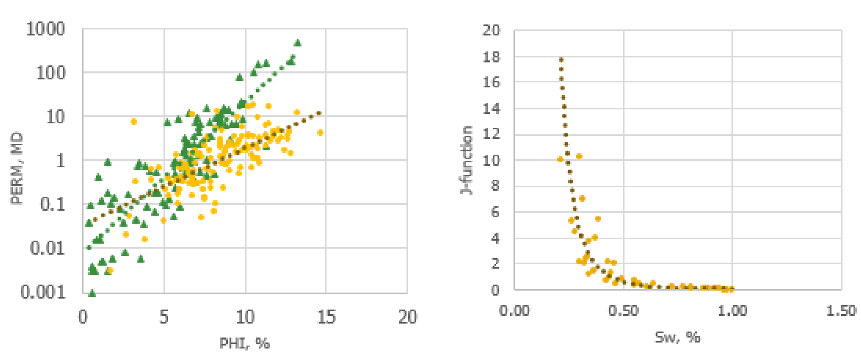

Figure 3. The use of various dependencies for the selected facies groups led to an improvement in the convergence of well log data and hydrodynamic logging data.

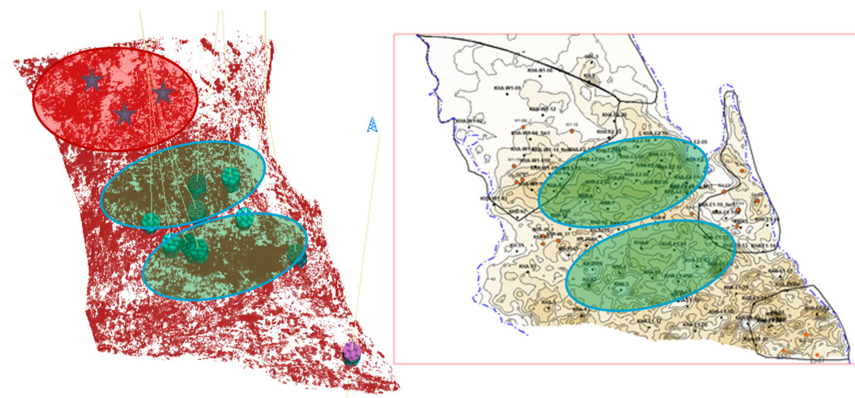

Figure 4. The results of the methodology converged well with current understanding of the reserves distribution and served as a complementary tool for confirming the accuracy of additional exploratory well placement.

Conclusion

The integrated analysis of multi-scale geological, geophysical and seismic information using machine learning methods provides a reliable prediction of facies identified from well data. This enhances the accuracy of the interpretation and helps specify promising zones and increased oil saturation (Figure 5). Based on the results of the analysis the customer was able to reduce geological risk during subsequent well placement.

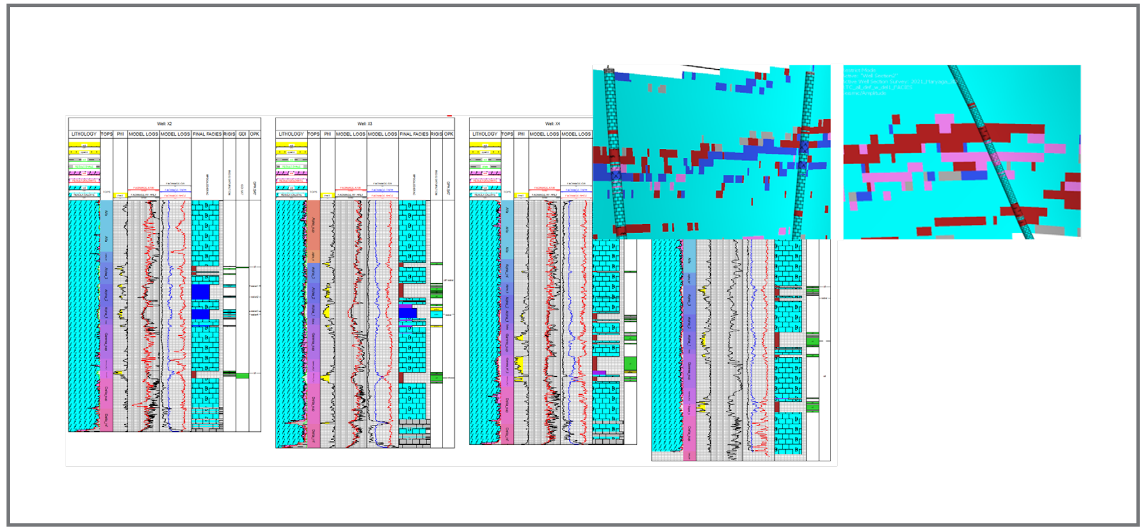

Figure 5. Increased reliability of interpretation and express assessment of oil-saturated effective thickness using integrated analysis of borehole and seismic studies through machine learning.

About AspenTech

Aspen Technology, Inc. (NASDAQ: AZPN) is a global software leader helping industries at the forefront of the world's dual challenge meet the increasing demand for resources from a rapidly growing population in a profitable and sustainable manner. AspenTech solutions address complex environments where it is critical to optimize the asset design, operation and maintenance lifecycle. Through our unique combination of deep domain expertise and innovation, customers in capital-intensive industries can run their assets safer, greener, longer and faster to improve their operational excellence.

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