Point of view

AI-ML Techniques help Reduce **Seismic Interpretation Cycle Time**

A Larsen & Toubro Group Company

Introduction

Upstream Oil and Gas is a data-driven industry where the success of any exploration campaign depends primarily on the subsurface data, such as seismic and available drilled-well information. Seismic 3D is acquired over areas extending from a few hundred square miles onshore to more than thousands of square miles offshore in the exploration phase. Recent developments in geophone and data recording capabilities have enabled geophysicists to acquire seismic data up to a record length of 10-14 seconds for imaging deeper geological sections [1]. This translates into terabytes of raw data that undergoes an end-to-end cycle of seismic API (acquisition, processing, and interpretation).

Interpretation of the acquired seismic data is the primary step and the backbone of the exploration campaign. Traditionally, experienced geoscientists spend months studying, analyzing, correlating, and interpreting seismic data to identify the hydrocarbon reserves. Specialized petro-technical application suites, such as Petrel, DSG, and Kingdom Suite, help seismic interpreters map horizons, faults, well-correlation, attribute analysis, and DHI studies. The final deliverables, after end-to-end interpretation, are drill-ready prospects along with the estimated in-place oil and gas volumes and the associated Geological Chance Factor (GCF). Typically, the turnaround time from seismic data acquisition to interpretation can extend to more than a year and a half. As exploration campaigns extend to geologically challenging areas where drilling of wells is extremely complex, there are continuous demands to increase the accuracy of interpretation and at the same time reduce the time to "first oil" through faster seismic interpretation processes.

Automated Seismic interpretation using AI-ML techniques

Exploration companies worldwide are now leveraging machine learning, AI techniques, and custom processing workflows to automate seismic interpretation. The preliminary interpretation tasks like horizon and fault delineation, attribute volume generation on multiple seismic volumes are carried out by AI-ML algorithm-based automated workflows, thereby saving significant time. The Subject Matter Experts (SMEs) can focus on interpreting the attribute patterns, maps, and integration of drilled datasets rather than on the volume interpretational aspects like horizon tracking, well seismic correlation, and attribute volume preparation.

Methodology

There are two primary types of machine learning algorithms used in seismic interpretation: Supervised and Unsupervised classification. Supervised classification methods use a known dataset to train the algorithms and then interpret a similar dataset. They use regression techniques to predict continuous measurement based on data calibrated at the drilled well locations. However, one of the main challenges in using supervised classification workflows is the inherent heterogeneity of the earth's subsurface lithology. Due to this heterogeneity, the rock and fluid properties change as the interpreter moves further away from the drilled well location (known areas) to the frontier (unknown) areas.

Unsupervised classification, on the other hand, does not require a labeled dataset. It uses cluster methods to create groups within the dataset based on hidden patterns within the data. Specialized seismic interpreters can then correlate these data patterns to subsurface lithology and fluid variations. Unsupervised algorithms are best used for predicting lithology and fluid properties. The several unsupervised algorithms include Principal Component Analysis (PCA), K Means clustering, Markov models, and Hierarchical clustering. This method is more applicable in rank exploratory areas where the drilled well information is limited.

Changing Workflows due to Automated Interpretation techniques

In a conventional workflow, seismic stratigraphers interpret the entire seismic volume by analyzing a series of data along inlines and Xlines and then interpolating the results. Recently, largescale developments in ML algorithms, high-performance computing, and open-source libraries have enabled enhanced automation of large portions of these interpretation workflows. Now, automated AI-ML-based algorithms can interpret the entire dataset using minimum inputs from geoscientists. Algorithms like convolutional deep neural networks can solve complex seismic to well ties, structural interpretation, and Quantitative Interpretation. ML-based synthetic seismic to well tie analysis have proven to be more accurate, data driven, and multiple times faster than conventional workflows. Neural network technology is currently being used to identify seismic facies analysis through multi-attribute analysis of the seismic volumes. Experienced seismic interpreters can then correlate these anomalies with hydrocarbon accumulation, lithology, and fluid property variations based on drilled well information. Automated interpretational tools have proven to reduce the seismic interpretation cycle time by more than 50% [2].

Conclusion

Conventional seismic interpretation techniques based on seismic reflection data and attribute analysis still form the primary workflow for prospect identification and hydrocarbon volume estimation. However, there has been a greater use and adoption of AI-ML-based techniques that significantly increase the efficiencies in interpreting, integrating, and analyzing subsurface seismic and well datasets. Automated processes assist seismic interpretation through extraction and comparison of large sets of seismic attributes, a rapid combination of attributes to form seismic anomaly patterns, and faster interpretation of horizons based on seed picking. Technologies such as neural networks have been found extremely effective in well to seismic correlation. In the new ways of working, the experienced seismic interpreters focus only on data integration and correlation of the patterns/anomalies brought out by the automated tools to the subsurface variation of lithology and fluid content. Thus, AI-ML-based algorithms have improved seismic interpretation workflows through faster-automated workflows and have increased accuracy through data insights and multivariate pattern analysis. An ideal interpretational workflow combines the power of AI-ML-based automated workflows with the experience and expertise of seismic interpreters to discover newer oil and gas pools.

References

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Sidhartha holds a Master's degree in Applied Geology from IIT-Roorkee and has 15 + years of work experience as an integrated Exploration Geoscientist in the Hydrocarbon Upstream Industry. His current role includes providing strategic solutions for multiple subsurface Data Management, Data transformation and Well planning automation projects. Sidhartha's areas of expertise include oil and gas exploration workflows, subsurface data interpretation, drilling plan optimization, OSDU adoption, petro-technical application deployment and support for the Oil & Gas industry.