Reliability of seismic data for hydrocarbon reservoir characterization

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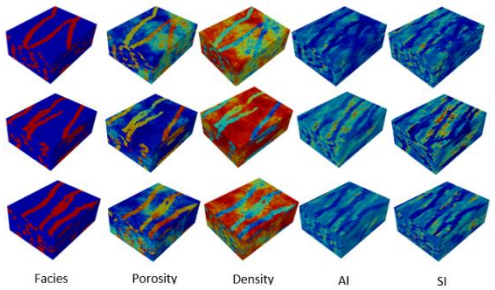
Abstract

Seismic data helps in better characterization of hydrocarbon reservoirs. However, seismic data is not perfect, and it is important to measure the reliability of the data. In this project, the reliability of seismic data is quantified by generating many stochastic realizations of reservoir properties from two possible geologic scenarios of a synthetic hydrocarbon reservoir, forward modeling the seismic data on each of those realizations using rock physics modeling, extracting features from the seismic data, and then using classification algorithms to classify a test set of realizations into either geologic scenario and computing the classification success rate.

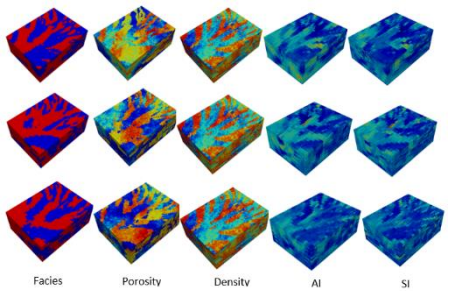
Modeling the Data

100 realizations of the reservoir property – facies – were generated using the geostatistical algorithm SNESIM (Single Normal Equation Simulation) for each of two possible geologic scenarios – a channel depositional system and a deltaic depositional system. Two other reservoir properties – porosity and density – were then simulated using SGSIM (Sequential Gaussian Simulation) conditioned on each facies realization. Then, rock physics modeling combined with Born filter was used to generate the acoustic impedance (AI) and S-wave impedance (SI) data.

Channel scenario



Delta scenario

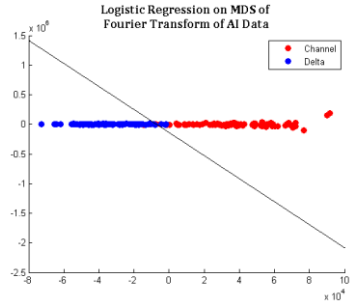


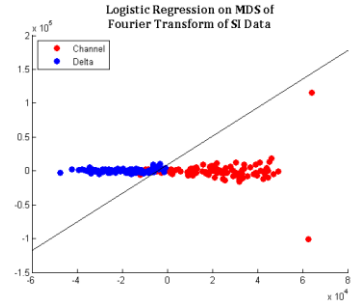
Extracting Features

AI and SI Data → 3D Fourier Transform → Multi Dimensional Scaling

Classification

1. Logistic Regression
2. Bayesian Classification
3. SVM classification





Results

Logistic Regression

Actual	Predicted: Channel	Predicted: Delta
Channel	94.0%	6.0%
Delta	4.0%	96.0%

AI

Actual	Predicted: Channel	Predicted: Delta
Channel	90.5%	9.5%
Delta	3.6%	96.4%

SI

Bayesian Classification

Actual	Predicted: Channel	Predicted: Delta
Channel	89.1%	10.9%
Delta	0.0%	100.0%

AI

Actual	Predicted: Channel	Predicted: Delta
Channel	83.6%	16.4%
Delta	0.0%	100.0%

SI

SVM Classification

Actual	Predicted: Channel	Predicted: Delta
Channel	92.6%	7.4%
Delta	3.3%	96.7%

AI

Actual	Predicted: Channel	Predicted: Delta
Channel	88.5%	11.5%
Delta	1.3%	98.7%

SI

References

1. Strebelle, S., 2002, Conditional simulation of complex geological structures using multiple-point statistics, *Mathematical Geology*, v. 34, no. 1, p. 1-21.
2. Mukerji, T., Mavko, G., & Rio, P., 1997, Scales of Reservoir Heterogeneities and Impact of Seismic Resolution on Geostatistical Integration, *Mathematical Geology*, v. 29, no. 7, p. 933-950.