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Please fill in your manuscript title.	Advancement of Machine Learning Approaches for Seismic Facies Classification - Generative Topographic Mapping (GTM) Over Self-Organizing Maps (SOM)

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Abstract

Objective

One of the key objectives of seismic interpretation is to effectively predict and map the distribution of reservoir facies in a 3D sense. Machine learning based seismic facies classification uses seismic data and other relevant attributes to arrange similar seismic traces based on the waveform shape, amplitude, phase, frequency. These automated facies classification techniques are fast and effectively map the facies distribution and sweet spots, using relevant seismic multi-attributes. Posteriori supervision of these unsupervised classification results along with integration of well data, helps in calibration and identification of better facies and sweet spots.

Method

Kohonen Self-Organizing Maps (SOM) has been a popular unsupervised learning algorithm for seismic facies classification. Here higher dimensional data is projected onto lower dimensional latent space through statistical processes, preserving the geometrical relationship between the data points (Roy et al, 2010). Generative Topographic Mapping (GTM) is a latest unsupervised learning algorithm, based on probabilistic representation of the data-vectors in the latent space (Roy et al, 2014). SOM algorithm lacks a defined convergence criteria and the quantitative measure of confidence. GTM technique overcomes these shortcomings. In GTM, posterior probability projections can be cross-plotted for demonstrating the convergence and confidence measurements in the final iteration.

In this study, we demonstrate the application of these algorithms for facies classification to a dataset from offshore Nova Scotia. The available seismic data was preconditioned properly to make it amenable for seismic interpretation. Then seismic multi-attributes such as Coherent energy, Sobel-filter similarity, GLCM attributes, Spectral Decomposition, Principal Curvatures and Relative Acoustic Impedance were used as inputs in the classification processes.

Results and Conclusions

Using the results of GTM and SOM techniques, lateral facies distributions were mapped effectively in the zone of interest within Logan Canyon and Missiasauga formations. A few confined channels and subtle stratigraphic features were also portrayed clearly on the facies maps, which were otherwise not clearly distinguished on the individual attributes.

Furthermore, GTM workflow was helpful in demonstrating the convergence process and confidence measure of the results using the posteriori probability projections. Through posteriori supervision of the classification results integrating well data, we were able to calibrate, identify the better facies and map the facies distribution laterally. GTM technique, thus, served as a more advanced tool, that demonstrated a robust QC process and lent confidence to use the results for further interpretation.

Novel/Additive Information

Automated facies classification workflows helped accelerating the interpretation process. Furthermore, the posteriori probabilistic projections in GTM workflow made this approach more robust and distinct, as it helped in visualizing the convergence process and demonstrating the confidence measure of the results. These unsupervised workflows may prove to be extremely beneficial in the exploration stage of the field lifecycle, with minimal availability of well data.