Attribute Analysis in Unconventional Resource Plays Using Unsupervised Neural Networks

**Analysis of Unconventional Resource using Inversion attributes and seismic attributes:**

Key elements in understanding unconventional resource plays encompass the following categories:

**Reservoir Geology**: thickness, lateral extent, stratigraphy, mineralogy, porosity and permeability

**Geochemistry**: Total Organic Content (TOC), maturity (Ro-heat), and kerogen% (richness)

**Geomechanics**: acoustic impedance inversion, Young’s modulus, Poisson’s ratio (Vp/Vs) and pressures

**Faults, Fractures, and Stress Regimes**: coherency (similarity), curvature, fault volumes, velocity anisotrophy (azimuthal distribution) and stress maps.

This case study involved a newly acquired 3D seismic volume in a fringe area of the Eagle Ford Shale Trend. The 3D is approximately 10 square miles and four wells had been drilled to date on 2D data previously interpreted. Two wells targeted the Eagle Ford Shale Formation, and another two wells were drilled for the Austin Chalk and the Buda Lime Formations. All four wells were drilled in normal pressured reservoirs with mixed results when it came to quality shows and commercial production.

After processing the 3D volume and initial interpretation was completed, well results and logs were incorporated by the client to create critical inversion attributes known to assist in the assessment of the shale’s productivity. Attributes contributed by the client to the analysis were: Final Density, Lambda Rho, MuRho, Poisson’s Brittleness, Poisson’s Ratio, Shear Impedance, Brittleness Coefficient, and P-impedance. Additional attributes run for the analysis were: Spectral Decomposition volumes, curvature and similarity volumes, Instantaneous attributes and Amplitude-related volumes (Average Energy and Sweetness).

The zone of study was confined to roughly the Top Austin Chalk to the Top of the Edwards Lime, encompassing the Austin Chalk, Eagle Ford Shale and Buda Limestone, which was approximately from 1.2 to 1.6 seconds.

In addition to the PSTM volume, the generated plus client-provided attributes used to highlight sweet spots included:

- Attenuation
- Bandwidth
- Envelope Slope
- Instantaneous Q
- MuRho
- S-Impedance
- Trace Envelope
- Young’s Brittleness

A 12 x 6 topology was used for the analysis, so there were 72 neurons training on the attribute information. Figure 1 is a time slice showing the interpreted “sweet spots” in the Eagle Ford Shale on the 3D from the SOM Analysis.
Two wells had been drilled, targeting the Eagle Ford Shale Formation. One was drilled prior to the acquisition of the data, and had few shows. It was plugged as a non-commercial well. The second well had good shows in the horizontal section of the hole, but encountered mechanical difficulties during drilling and had to be temporarily plugged.

Figure 2 is an arbitrary seismic line through the deviated borehole of the second well showing the anomalous zone in both the Eagle Ford and Buda Formations and the points at which the well encountered the shows.

In conclusion, SOM analysis proved to be complementary to the interpretation of the data. The company who owns this 3D is now planning on targeting the area with five additional wells in the coming year. The application of using SOM analysis using selected seismic attributes can dramatically reduce uncertainty and thus decrease exploration risk in unconventional reservoirs.