TETRA TECH RPS ENERGY | TRAINING

# N049: Seismic Attributes for Exploration and Reservoir Characterisation

Instructor(s): John Castagna

**Format and Duration**

Classroom - 5 Days
Virtual - 10 Sessions

## Summary

Lecture and exercise materials cover interpretation workflows using attributes currently available on most modern workstations as well as recently developed seismic applications designed to extract the smaller scale geologic details required for the construction of reservoir models.

Business Impact: Students will gain the skills required to select and apply a broad range of seismic attributes including combined attributes in exploration and reservoir characterization projects.

## Learning Outcomes

Participants will learn to:

1. Review seismic wave fundamentals including the convolutional model, tuning, phase and understand the importance of maximizing seismic bandwidth.
2. Assess the role of post stack attribute tools commonly found in most workstation software in seismic interpretation workflows. Examples include the use of max/min amplitude, instantaneous frequency/phase, curvature, coherency and dip/azimuth attributes as structural or stratigraphic indicators.
3. Evaluate the role of AVO (amplitude vs. reflection angle) measurements to address specific interpretation problems including fluid prediction and the estimation of elastic rock properties.
4. Investigate the use of spectral enhancement attributes such as Sparse Layer Inversion in interpretation workflows.
5. Appraise the use of geo-statistical tools, spectral decomposition, and multi-attribute analysis in reservoir characterization.
6. Recognize the limitations of AVO tools, post stack inversion, and other seismic attributes.
7. Develop fit-for-purpose interpretation workflows for several exploration and production problems in the classroom.

## Training Method

This is a classroom or virtual classroom course comprising a mixture of lectures, data examples, case studies, and practical exercises.

## Who Should Attend

This course has been designed for geoscientists possessing; 1) a basic understanding of the fundamentals of seismic technology including data processing, 2) having a minimum of three years experience interpreting 3D seismic data, and 3) who are interested in learning more about the application of seismic attributes to achieve exploration, reservoir characterization and production objectives.

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## Course Content

1. Introduction

2. Review of seismic imaging fundamentals

- Rock physics
- Seismic wave propagation
- The convolutional model & reflectivity
- Factors affecting seismic resolution
- Benefits of 3-D imaging

3. Overview of commonly used seismic attributes

- Amplitude attributes
- Complex trace attributes
- Spatial attributes
- Post stack seismic inversion
- Spectral decomposition
- Isochron & residual maps

4. Visualization tools

5. Elastic response attributes

- AVO
- Lambda-mu-rho
- Elastic impedance
- Direct hydrocarbon indicators

6. Spectral enhancement/extension

7. Reservoir characterization

- Cross plot analysis
- Multi-attribute analysis
- Neural networks
- Geostatistical analysis
- Validation and significance testing

8. Interpretation workflow presentations by class

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### 9. Exercises

This course integrates practical exercises to complement theoretical learning. You will:

- **Analyze seismic attributes** to understand their impact on data information content.
- **Evaluate correlation coefficients** to predict reservoir porosity.
- **Answer true or false questions** on various seismic concepts, such as seismic response, frequency response, and seismic resolution.
- **Identify inadequacies** in the convolutional model for seismic wave propagation.
- **Describe characteristics** of wavelets and their applications.
- **Perform synthetic seismogram exercises**, identifying potential pitfalls in each step.
- **Identify errors** in synthetic seismogram figures.
- **Understand deconvolution techniques** and their limitations.
- **Discuss factors** affecting seismic amplitudes.
- **Critique definitions** of seismic concepts like the Fresnel zone.
- **Interpret seismic signatures** and their corresponding impedance profiles.
- **Delineate channels** using seismic data.
- **Answer tuning-related questions** to understand seismic resolution limits.
- **Explore the benefits** of 3D seismic data in geological and engineering contexts.
- **Identify hydrocarbon indicators** from seismic data.
- **Analyze curvature** in geological structures.
- **Discuss deep water depositional environments** and relevant seismic attributes.
- **Combine amplitude and coherence** for lithology interpretation.
- **Identify and interpret direct hydrocarbon indicators (DHIs)**.
- **Compare inverted and original seismic data** to explain horizon picks.
- **Apply Bayes' Theorem** to assess the probability of productive zones.
- **Upscale rock properties** for reservoir characterization.
- **Conduct 1-D experiments** related to synthetic inversion and frequency analysis.

These exercises will provide hands-on experience and deepen your understanding of seismic attributes and their applications in exploration and reservoir characterization.