TETRA TECH RPS ENERGY | TRAINING

# N469: The Practice and Theory of Seismic Depth Imaging: Conventional and Unconventional Plays

Instructor(s): David Kessler

**Format and Duration**

Classroom - 3 Days
Virtual - 6 Sessions

## Summary

Many petroleum companies routinely utilize pre-stack depth imaging technology in seismic processing workflows for both conventional and unconventional plays. Participants will become familiar with the underlying theory and current industry practices in the application of pre-stack depth imaging technology in conventional and unconventional plays through the use of case studies located in both onshore and offshore environments. Depth imaging provides superior results compared to time processing including accurate time-to-depth conversions for well planning, reliable velocity models for pore pressure prediction, and superior geohazard identification.

Business Impact: The depth imaging knowledge acquired in this course will enable participants to improve success rates and decrease drilling risks by reducing structural uncertainty and developing better technical decisions.

## Learning Outcomes

Participants will learn to:

1. Investigate the differences between time and depth imaging and understand the practical benefits of utilizing pre-stack seismic imaging workflows.
2. Evaluate the various methods currently in use for pre-stack depth imaging.
3. Investigate the influence of anisotropy in depth imaging.
4. Demonstrate how velocity models are constructed and optimized for pre-stack depth imaging projects.
5. Construct practical interpretation workflows to analyze sub-salt seismic data.
6. Supervise the parameterization of pre-stack depth migration projects.

## Training Method

This classroom course combines lectures, case history discussions and several classroom exercises.

## Who Should Attend

This course has been designed for both seismic interpreters and geophysicists involved in any use or evaluation of seismic data. The course is very suitable for engineers that are using seismic data to optimize drilling programs. Course participants will be able to successfully understand depth migrated seismic data, know how to differentiate signal from artifacts, understand new methods and workflows, and learn about the state-of-the-art of seismic depth imaging technology. The course is very much recommended to QI geophysicists working with seismic data as input to seismic inversion and evaluation of rock properties.

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## Course Content

### Topic I – Basic Concepts

- Chapter 1: General Review: Time and Depth Imaging Methods
- Chapter 2: The Theory of Post Stack and Pre-stack Depth Migration
- Chapter 3: From Theory to Practice: Migration Parameterization
  - Basic concepts and methods in both time and depth processing
  - Analysis of wave propagation
  - Offshore sub-salt example
  - Onshore faulted section example
  - Ray based depth migration
  - Kirchhoff summation migration
  - Travel time calculation used in ray-based depth migration
  - Wave equation downward continuation
  - Wave equation imaging condition
  - One-way wave equation depth migration
  - Two-way wave equation depth migration
  - Anisotropic depth migration
  - Computer hardware using for depth imaging
  - Parameterization of depth migration algorithms
  - Depth migration operator dip
  - Depth migration aperture
  - Depth migration frequency range
  - Various types and uses of PSDM image gathers

### Topic II – Model Building and Depth Imaging

- Chapter 4: Seismic Velocities and Velocity Estimation Techniques
- Chapter 5: Anisotropy and Time-to-Depth Conversion
- Chapter 6: Interpretation and Model Building
  - Definitions of velocity fields used in seismic processing and depth imaging
  - Velocity analysis techniques
  - Implementation of Reflection tomography
  - Implementation of Full waveform inversion
  - Time to depth conversion using pre-stack depth migration
  - Seismic to well mistie analysis and correction
  - Definition of anisotropic models
  - Wave propagation in an anisotropic media
  - Model building and depth imaging of unconventional plays
  - Estimation of fracture orientation using azimuthal anisotropy

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- Onshore conventional fault shadow example
- Onshore unconventional shale play example
- The link between velocity models and pre-stack depth migration results
- Salt model building workflow
- Models for imaging of over thrust geology
- Fault shadows
- Construction of anisotropic models for unconventional plays

### Topic III – Interpretation and Analysis

- Chapter 7: Velocity Model and Image Quality
- Chapter 8: Imaging and Interpretation of Sub-Salt Sediments
- Chapter 9: PSDM Amplitudes
- Chapter 10: Depth Imaging Projects, Workflows and Examples
  - Optimization of velocity models
  - The relation between anisotropic models and image accuracy
  - Challenges of imaging and interpretation of the subsalt section
  - Sub-salt multiples, converted waves and prism waves
  - Offshore sub-salt example
  - Onshore over thrust example
  - Ray based illumination
  - Migration illumination
  - Amplitude preserved pre-stack depth migration
  - Wave equation normalization
  - Impedance inversion using pre-stack depth migrated gathers
  - Depth imaging workflows
  - Steps for execution of depth imaging projects
  - The link between depth imaging technology and exploration and development