COURSE OVERVIEW DE0896
3D Seismic Attributes for Reservoir Characterization (E-Learning Module)

Course Title
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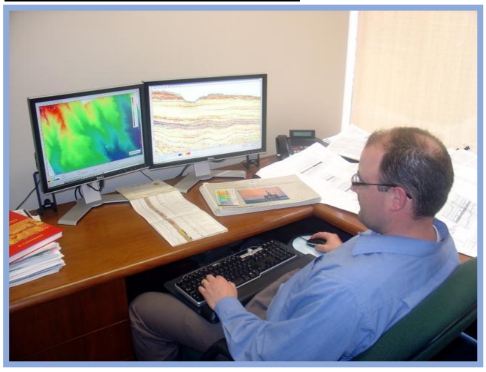
Course Reference
DE0896

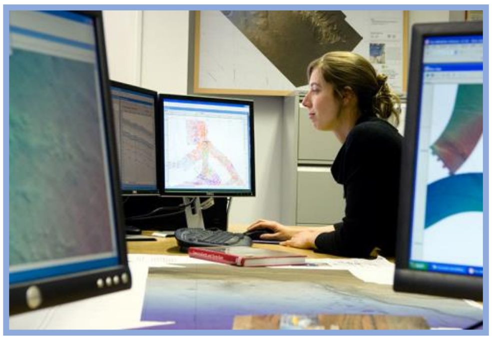
Course Format & Compatibility
SCORM 1.2. Compatible with IE11, MS-Edge, Google Chrome, Windows, Linux, Unix, Android, IOS, iPadOS, macOS, iPhone, iPad & HarmonyOS (Huawei)

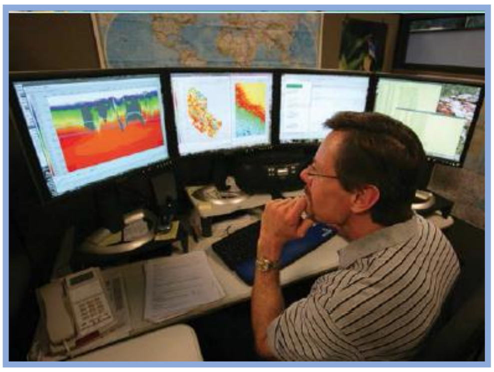
Course Duration
30 online contact hours
(3.0 CEUs/30 PDHs)

3.0 CEUs (30 PDHs) AWARD

Course Description







This E-Learning is designed to provide participants with a detailed and up-to-date overview of 3D seismic attributes for reservoir characterization. It covers the 3D seismic attributes for reservoir characterization, advanced seismic attributes analysis, attributes, amplitude envelope and instantaneous frequency and phase; the response frequency, seismic coherence and multi-trace seismic attributes; the quantitative seismic attributes interpretation; the basic rock properties, seismic attributes and RMS amplitude; and the quantitative analysis methods, well data and seismic attribute correlation, waveform classification and fracture analysis using curvature attributes.

During this interactive course, participants will learn the seismic facies classification, multi-attribute analysis, in seismic reservoir management, seismic interpretation and stratigraphic interpretation using seismic attributes; the edge-preserving filtering, reservoir characterization workflows and 3-D texture analysis and computer-aided object detection; the 3D-seismic attributes in reservoir characterization; the seismic reflection method and interpretation; and the thickness calibration and the 3 approaches to analyze thin bed tuning.

Course Objectives

After completing the course, the employee will:-

- Apply and gain an in-depth knowledge on 3D seismic attributes for reservoir characterization
- Use attributes to enhance subtle faults and folds, as lithologic indicators, and quality control the choice of processing parameters
- Evaluate and exploit attribute expressions for different depositional environments to better characterize reservoirs by adopting appropriate workflows and multi-attribute tools
- Identify geological features highlighted by attributes, limitations to seismic processing through attributes that may result in smeared attribute images from multi-azimuth and multi-offset data, limits of attribute analysis on data that have been poorly imaged and good and bad color display practices
- Discuss the 3D seismic attributes for reservoir characterization, advanced seismic attributes analysis, attributes, amplitude envelope and instantaneous frequency and phase
- Identify response frequency, seismic coherence and multi-trace seismic attributes
- Carryout quantitative seismic attributes interpretation and describe basic rock properties, seismic attributes and RMS amplitude
- Employ quantitative analysis methods, well data and seismic attribute correlation, waveform classification and fracture analysis using curvature attributes
- Apply seismic facies classification, multi-attribute analysis, in seismic reservoir management, seismic interpretation and stratigraphic interpretation using seismic attributes
- Illustrate edge-preserving filtering, reservoir characterization workflows and 3-D texture analysis and computer-aided object detection
- Use 3D-seismic attributes in reservoir characterization and apply the seismic reflection method and interpretation
- Carryout thickness calibration and the 3 approaches to analyze thin bed tuning

Who Should Attend

This course provides an overview of all significant aspects and considerations of 3D seismic attributes for reservoir characterization for organisations and individuals that are migrating to Petrel from Interpretation Window-focused software as well as staff that may be sheltering in a serial 2D approach to 3D interpretation. It can also be adapted to accommodate geoscientists without an interpretation background such graduates, geomodellers and processing geophysicists.

Course Certificate(s)

Internationally recognized certificates will be issued to all participants of the course.

Certificate Accreditations

Certificates are accredited by the following international accreditation organizations: -

- USA International Association for Continuing Education and Training (IACET)

  Haward Technology is an Authorized Training Provider by the International Association for Continuing Education and Training (IACET), 2201 Cooperative Way, Suite 600, Herndon, VA 20171, USA. In obtaining this authority, Haward Technology has demonstrated that it complies with the **ANSI/IACET 1-2013 Standard** which is widely recognized as the standard of good practice internationally. As a result of our Authorized Provider membership status, Haward Technology is authorized to offer IACET CEUs for its programs that qualify under the **ANSI/IACET 1-2013 Standard**.

  Haward Technology's courses meet the professional certification and continuing education requirements for participants seeking **Continuing Education Units** (CEUs) in accordance with the rules & regulations of the International Association for Continuing Education & Training (IACET). IACET is an international authority that evaluates programs according to strict, research-based criteria and guidelines. The CEU is an internationally accepted uniform unit of measurement in qualified courses of continuing education.

  Haward Technology Middle East will award **3.0 CEUs** (Continuing Education Units) or **30 PDHs** (Professional Development Hours) for participants who completed the total tuition hours of this program. One CEU is equivalent to ten Professional Development Hours (PDHs) or ten contact hours of the participation in and completion of Haward Technology programs. A permanent record of a participant's involvement and awarding of CEU will be maintained by Haward Technology. Haward Technology will provide a copy of the participant's CEU and PDH Transcript of Records upon request.

- British Accreditation Council (BAC)

  Haward Technology is accredited by the **British Accreditation Council** for **Independent Further and Higher Education** as an **International Centre**. BAC is the British accrediting body responsible for setting standards within independent further and higher education sector in the UK and overseas. As a BAC-accredited international centre, Haward Technology meets all of the international higher education criteria and standards set by BAC.

Course Fee

As per proposal

Training Methodology

This Trainee-centered course includes the following training methodologies:-

- Talking presentation Slides (ppt with audio)
- Simulation & Animation
- Exercises
- Videos
- Case Studies
- Gamification (learning through games)
- Quizzes, Pre-test & Post-test

Every section/module of the course ends up with a Quiz which must be passed by the trainee in order to move to the next section/module. A Post-test at the end of the course must be passed in order to get the online accredited certificate.

Course Contents

- 3D Seismic Attributes for Reservoir Characterization
- The Advanced Seismic Attributes Analysis
- Attributes
- What is a 3D Seismic Attribute
- Instantaneous Attributes
- Amplitude Envelope
- Instantaneous Frequency
- Instantaneous Phase
- Wavelet Attributes
- Geometrical Attributes
- Reflection Strength
- Perigram
- Apparent Polarity
- Response Phase
- Cosine of Phase
- Perigram * Cosine of Phase
- Response Frequency
- Seismic Coherence
- Coherence

- Multi-Trace Seismic Attributes
- Dip/Azimuth
- Why Use Seismic Coherence?
- Nigerian Continental Slope
- Conclusions
- Quantitative Seismic Attributes Interpretation
- Why do we need quantitative interpretation?
- The Essentials of Amplitude Interpretation
- Basic Rock Properties
- Seismic Attributes
- Attributes Product of Seismic Inversion
- Seismic Attributes Group
- RMS Amplitude
- Average Absolute Amplitude
- Maximum Peak Amplitude
- Average Peak Amplitude
- Maximum Trough Amplitude
- Maximum Absolute Amplitude
- Total Absolute Amplitude
- Total Amplitude
- Average Energy
- Total Energy
- Mean Amplitude
- Attribute Sensitivity
- Summary Of Attribute Applications
- Quantitative Analysis Methods
- Well data and Seismic Attribute Correlation
- Seismic Derived Net Pay Map
- Waveform Classification
- Supervised Waveform Classification
- Un-supervised Waveform Classification
- Quantitative Analysis Result Using Discriminant Analysis
- Seismic Reservoir Analysis Using Seismic Attributes

- Coherence Attributes
- Curvature Attributes
- Multi-Spectral Estimates of Curvatures
- Reflector Convergence
- Seismic Attributes
- Fracture Analysis Using Curvature Attributes
- Visualization of Attributes
- Thin-bed Reflectivity
- Correction for Spurious Phase Via Estimation of Non-minimum Phase Wavelet
- Spectral Decomposition
- Seismic Facies Classification
- Angle-Dependent Inversion
- Extended Elastic Impedance Inversion
- Multi-attribute Analysis
- Spectral Decomposition and Thin Bed Tuning
- Spectral decomposition work flow
- Color display and 3-D visualization
- 16 Hz amplitude component
- Instantaneous envelope
- Application of spectral decomposition and coherence: Midcontinent, USA
- Pick a continuous horizon parallel to eroded formation
- Apply spectral decomposition between phantom horizons
- Geology 101: "What you see is what's preserved!"
- Coherence extraction along a 'phantom horizon' 36 ms below Skinner
- Gulf of Mexico sand fan
- Lateral detection is different than vertical resolution!
- Simultaneous display of 3 attributes will therefore show more of the data!
- Spectral Balancing to compensate for source wavelet and energy loss with depth
- Spectrum of a 100 ms analysis window
- peak frequency (100 ms window)
- coherence interleaved with peak frequency
- This feature is below seismic resolution!
- Horizon and formation attributes

- Amplitude extraction
- Amplitude extraction maps provide stratigraphic information
- Near Reflector Geometry
- Formation or interval attributes
- In seismic Reservoir Management
- Defining the Geometric Framework of the Reservoir
- Angola Prospectivity from Seismic
- Seismic Interpretation
- High Resolution Seismic Data Enables the Definition of Sedimentary Features and Stratigraphic Trap Styles
- Seismic Time Slice
- Coherence Time Slice
- Stratigraphic Interpretation Using Seismic Attributes
- Stratigraphic Interpretation
- Seismic Stratigraphy – 3-D Capabilities
- Stratigraphic Interpretation – Coherence Timslices
- Definition
- Definition of Seismic Attributes
- An alternative working definition
- Spectral decomposition and thin bed tuning
- Color display and 3-D visualization
- Complex trace attributes
- Horizon and formation attributes
- Geometric Attributes
- Volumetric curvature
- Attribute expression of structure and stratigraphy
- Edge-preserving filtering
- Inversion for acoustic and elastic impedances
- Reservoir characterization workflows
- 3-D texture analysis and computer-aided object detection
- N. Impact of data quality on seismic attributes
- Multiattribute analysis tools
- Every day attributes and the search for hydrocarbons
- Advantages and disadvantages of seismic attributes

- Alternative workflows
- Coherence Horizon Slice
- Horizon Slice
- Time Slice
- Coherence without dip search
- Spectral Decomposition
- Spectral Decomposition Work Flow
- 16 Hz amplitude component
- 26 Hz amplitude component
- Instantaneous envelope
- Simultaneous display of 3 attributes will therefore show more of the data!
- Summary
- Using 3D-Seismic Attributes in Reservoir Characterization
- The Seismic Reflection Method
- Seismic Reflection Interpretation
- Seismic Applications in Petroleum Exploration
- What are Seismic Attributes?
- General Classes of Attributes
- Families of Seismic Attributes
- Definitions of Selected Attributes
- Instantaneous Attributes
- Spectral Decomposition
- Volumetric Curvature
- What Physical Information is provided by Seismic Attributes?
- Methods of Interpreting Attributes from 3-D Seismic Volumes
- Reservoir Characterization Examples
- Fault Interpretation – Offshore Trinidad
- Limits of Porous Reservoir – Mississipian Dolomite Reservoir Judica Field Ness and Gove Counties, KS
- Judica Field Stratigraphy
- Judica 3-D Seismic Survey
- Judica 3-D Attribute Analysis Results
- “Thin bed” Thickness Estimation – Upper Creaceous “D” Sand Sooner Unit, Colorado

- "D" Sand Reservoir
- "D" Sand Thickness from wells
- Vertical Seismic Section
- Cross-sectional view and 3-D visualization
- Sooner 3-D Seismic Survey "D" Sand is Isohron Map
- Discrete Fourier Component Thin Bed Tuning Analysis
- Instantaneous Frequency Extracted along Top "D" Sand Horizon
- Spectral Decomposition – 29Hz
- Crossplots of Attribute versus "D" Sand Thickness
- Fracture Delineation – Mississipian Reservoir Dickman Field Ness County, Kansas
- Dickman Mississipian Reservoir
- Shale-filled Fractures Intersected by Horizontal Wellness County, KS
- Seismic Attributes for Dileneating Faults and Fractures
- Volumetric Curvature – Gilmore City Horizon
- Interpreted Shale – and Debris – Filled Solution – Enlarged Fracture Coincides with NE-trending Curvature Lineament
- Thickness of karst zone in well versus distance to nearest NW and NE lineaments
- Oil Production versus Distance to Nearest NW and NE lineaments
- Water Production versus Distance to Nearest NW and NE lineaments
- Dickman 3-D Attribute Analysis Results
- Spectral Decomposition and Thin Bed Tuning
- The classic thin bed model
- Thin Bed Resolution
- Short window spectral decomposition and the convolutional model
- Long window spectral decomposition and the convolutional model
- The wedge model
- Spectral components of the wedge model
- Spectral Decomposition
- Spectral decomposition work flow
- 16 Hz amplitude component
- 26 Hz amplitude component
- Instantaneous envelope

- Application of spectral decomposition and coherence: Midcontinent, USA
- Pick a continuous horizon parallel to eroded formation
- Apply spectral decomposition between phantom horizons
- Cross correlate the seismic data with precomputed wave packets (sines and cosines)
- Geology 101: "What you see is what's preserved!"
- Coherence extraction along a 'phantom horizon' 36 ms below Skinner
- Incised valley from New Zealand
- Gulf of Mexico sand fan
- Lateral detection is different than vertical resolution!
- Why does spectral decomposition look better?
- Simultaneous display of 3 attributes will therefore show more of the data!
- Spectral Balancing to compensate for source wavelet and energy loss with depth
- Thickness Calibration
- 3 approaches to analyzing thin bed tuning
- Traditional thin bed tuning analysis
- Dominant frequency thin bed tuning analysis
- Discrete Fourier component thin bed tuning analysis
- Vertical seismic through channel
- Spectrum of a 100 ms analysis window
- peak frequency (100 ms window)
- coherence interleaved with peak frequency
- This feature is below seismic resolution!
- Thin bed resolution
- Instantaneous spectral attributes
- Wavelet (ISA) vs Discrete Fourier Transforms
- Wavelet Matching Algorithm how does it work?
- Wavelet matching algorithm
- Comparison
- The flow chart
- Common frequency sections
- ISA Case study – NW Australia
- ISA – 10 Hz component

- ISA – 20 Hz component
- ISA – 30 Hz component
- ISA applied to Burgos Basin
- Attenuation in Porous Media
- The 2-Q model: Frequency-dependent effects of thin porous fluid-saturated layer
- Amplitude as a function of frequency
- Western Siberia 2-D
- Western Siberia 2-D grid
- Energy Loss in Saturated Rock. Two Q Model
- Summary