COURSE OVERVIEW DE0806
Coring and Core Analysis
(E-Learning Module)

Course Title
Coring and Core Analysis
(E-Learning Module)

Course Reference
DE0806

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)

Course Description

More than three-quarters of current additions to the world's reserves come from better management of existing reserves. Core-based measurements offer the most tangible and direct means of determining critical reservoir parameters. Core analysis can play a vital role in field equity or unitization and is often considered to be the ground truth to which other measurements are compared (e.g., wireline logging). Evidence of hydrocarbon presence, reservoir storage capacity, and flow capacity along with the distribution of porosity, permeability, and geological descriptive information can be directly obtained from core material.

Core analysis is the fundamental foundation of reservoir characterization. Using a multidisciplinary approach, managerial, drilling, geological, and engineering requirements should all be considered. Design and application of core analysis is dependent on the coring method, the coring fluid systems, core handling at the wellsite, and core preservation techniques. Core analysis provides the building blocks for understanding fluid flow, ultimate recovery, and displacement efficiencies. Over 30 percent of the classroom time will be dedicated to data analysis, workshops, and case studies.

Course Objectives

After completing the course, the employee will:-

- Apply and gain systematic techniques on production logging
- Learn about what are the benefits of coring and how to set a clear objective of coring
- Design coring program in order to maximize recovery
- Learn how porosity, permeability, grain density and saturations are being measured - conventional core analysis
- Understand wettability, relative permeability, capillary pressure (SCAL) measurements and its applications
- Understand QC the data and integration with log and engineering data
- Identify rock types and cycling including the main types and characteristics of igneous rocks
- Discuss sedimentary rocks, carbonates. metamorphic rocks and some metamorphic changes
- Illustrate petroleum system process, kerogen maturation and petroleum system process
- Identify the criteria for determining the source rock potential including trapping mechanisms, hydrocarbon traps classification and petroleum system
- Discuss effective permeability as well as the factors affecting relative permeabilities and the characteristics of relative permeability functions
- Describe the physical characteristics of a reservoir and apply wireline logging operations, data acquisition methods and hole logging measurements
- Identify the basic logging tools, reservoir properties, caliper logs and the effect of shale on the sonic derived porosity
- Detect heavy minerals and inter-well correlation, calculate water saturation and apply qualitative interpretation and petrophysical interpretation procedure
- Employ shale and saturation evaluation, coring operations and selection of the core type and coring fluid
- Carryout wellsite core handling and preparation, core handling and preservation at the well site and alternate preservation methods
- Apply wellsite core sampling and plugging, laboratory core handling and preparation, core unpacking and layout and core orientation and marking
- Implement cleaning techniques and identify the factors affecting fluid saturations in cores, application of core saturations and estimating fluid contact depths from core saturations
- Classify wettability, recognize wettability measurements and apply coring analysis, full petrophysical analysis, seismic interpretation and attribute analysis

Who Should Attend

This course is intended for petroleum engineers, production engineers, drilling engineers, reservoir engineers, petrophysicists, log analysts, and anyone interested in understanding what production logs and cased-hole surveys.

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.

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 Fee

As per proposal

Course Contents

- Overview on Rock Types and Cycling
- Rocks
- Rocks are classified into three types based on their origin
- Igneous Rocks
- Description of Igneous Rocks
- Volcanic vs Plutonic Ingneous Rocks
- Overview on Rock Types and Cycling
- Main Types of Igneous Rocks
- Characteristics of Igneous Rocks
- Sedimentary Rocks
- Sediment
- Sedimentary Rocks (Weathering and Erosion)
- Sedimentary Rocks (Transportation)
- Sedimentary Rocks (Deposition)
- Sedimentary Rocks (Lithification Process)
- Sedimentary Rocks (Compaction)
- Sedimentary Rocks (Cementation)

- Sediment in a Stream
- Classification of Sedimentary Rocks
- Detrital (Clastic) Sedimentary Rocks
- Classification of Sedimentary Rocks
- Organic Rocks
- Chemical Rocks
- Chemical Rocks (Biochemical)
- Biochemical Sedimentary Rocks
- Chemical Rocks (Inorganic)
- Chemical Sedimentary Rocks
- Carbonates
- Metamorphic Rocks
- Metamorphism → Metamorphic Rocks
- Metamorphism
- Some Metamorphic Changes
- Main Types of Metamorphic Rocks
- Sediment
- The Rock Cycle is the interaction of Plate Tectonic and Climate Systems
- Introduction to Petroleum Industry
- Definition
- Hydrocarbon
- Petroleum System Process
- Inorganic Theory
- Organic Theory
- Coal and Oil Formation
- Origin of Petroleum (Kerogen)
- Definition and Formation
- Kerogen Maturation
- Diagenesis of Organic Matter
- Kerogen Types
- Van Krevelen Plot
- Petroleum System Process - Hydrocarbon Migration
- Primary Migration

- Secondary Migration
- Petroleum System Process - Hydrocarbon Accumulation
- Petroleum System Process – Timing
- Petroleum System Elements
- Reservoir Rock
- Seal Rock
- Petroleum System Elements - Petroleum Source Rocks
- Definition of Source Rock
- Criteria for Determining the Source Rock Potential
- What is Petroleum Geology?
- Petroleum System Elements - Petroleum Trap/ Cap Rocks
- Trapping Mechanisms
- Hydrocarbon Traps Classification
- Petroleum System
- Petroleum System Elements - Petroleum Reservoir Rocks
- Definition of Reservoir Rock
- Requirements of a Reservoir (Lithology)
- Requirements of a Reservoir (Porosity F)
- Requirements of a Reservoir (Permeability K)
- Permeability
- One Darcy
- Absolute permeability
- Multiphase Flow in Reservoirs
- Effective permeability
- Factors Affecting Relative Permeabilities
- Characteristics of Relative Permeability Functions
- Applications of Relative Permeability Functions
- Requirements of a Reservoir (Water Saturation Sw)
- Critical oil saturation, S_{oc}
- Residual oil saturation, Sor
- Movable oil saturation, S_{om}
- Critical gas saturation, S_{gc}
- Critical water saturation, Swc

- Reservoir Analysis
- Physical Characteristics of a Reservoir
- Physical characteristics of a reservoir include
- To be commercially productive it must have
- DepthShallow Reservoir
- Deep Reservoir
- Area and Thickness
- Petroleum System
- Two Main litthologies
- Principal of Well Logging
- Why We Log ?
- What is a well log?
- Well Log Introduction
- Who uses Logs and for what purposes?
- The Drilling Engineer
- The Reservoir Engineer
- Wireline Logging Operations
- Data Acquisition Methods
- Wireline Logs
- Open Hole
- Cased Hole
- Production Log
- Open Hole Logging Measurements
- Cased Hole Logging Measurements
- Production Logging Measurements
- Some disadvantages of Wireline Logging
- Logging While Drilling (L.W.D)
- Logging While Drilling Versus Wire Line Logging
- Measurements While Drilling
- Tools Theory and Uses
- Basic Logging Tools
- Basic Logging Tools and Interpretable Parameters
- Basic Logging Tools

- Lithology Logs
- Porosity Logs
- Saturation (Resistivity) Logs
- Reservoir Structure -Image logging – FMI/FMS/UBI etc.
- Reservoir Properties
- Caliper Logs
- Uses of the Caliper Log
- Spontaneous Potential Logging (SP)
- SP: Measurement and Principles
- Static Spontaneous Potential (SSP)
- Spontaneous Potential Logging(SP)
- Functions of Spontaneous Potential (SP) log
- SP as a Correlation Tool
- SP as a Permeability or Shale Indicator
- GR (Gamma Ray) Logging
- Principle
- Applications
- The Natural Gamma Ray Spectrometry (SGR)
- Spectral Gamma Ray Log
- Gamma Ray Log
- Unconformity Detection
- Inter-well Correlation
- Recognition of Igneous Rocks
- Sedimentology
- Porosity Logs
- Sonic Logging Tool
- The Effect of Shale on the Sonic Derived Porosity
- The Effect of Gas on the Sonic Derived Porosity
- Detection of the presence of Natural Gas
- The Effect of Shale / Gas on the Sonic Derived Porosity
- Identification of Lithologies
- Stratigraphic Correlation
- Compaction

- Overpressure
- The Formation Density Log
- The Formation Density Tool
- Determination of Porosity
- Identification of Lithology
- Shale Compaction, Age, and Unconformities
- The Litho-Density Log
- Recognition of Clay Minerals Types
- Detection of Heavy Minerals and Inter-Well Correlation
- The Neutron Log
- Principle
- Measurements
- Hydrogen Index
- Main Types of Neutron Logging Tools
- Applications
- Lithological Identification using the Neutron-Density Combination
- Electric Resistivity Logging Tools
- Resistivity Logging Tools
- Laterolog Applications
- Induction Logs
- Induction Logs (Principle and Theory)
- The Dual Induction- Laterolog
- Which Resistivity tool to run?
- Recognition of Hydrocarbon Zones
- Textures and Facies Recognition
- CorrelationLithology Recognition
- Other Applications
- Calculation of Water Saturation
- Petrophysical Interpretation
- Basic Log Interpretation Concepts
- Qualitative
- Quantitative
- Qualitative Interpretation

- Petrophysical Interpretation Procedure
- Zoning (Bed Boundary)
- Lithology General
- Petrophysical Interpretation Procedure
- Lithology Identification (Logging Tools)
- Lithology Identification (Cross Plots)
- Identifying The Reservoir
- Identifying the Fluid Type and Contacts
- Calculating The Porosity (ϕ)
- Porosity Logs
- Hydrocarbon Indicators
- Calculating Hydrocarbon Saturation (Sh)
- Hydrocarbon Saturation Equations (Archie's Equation)
- Hydrocarbon Saturation Equations (Formation Factor)
- Hydrocarbon Saturation Equations (Invaded Zone)
- Permeability Determination (K)
- Formation Evaluation – Well Log Interpretation
- Quick look Interpretation Summary
- Identification of Reservoir and Non-Reservoir Rocks
- Qualitative Interpretation of Well Logs
- Quick look Summary of Estimation of Water Saturation (Sw) by using Archie's Equation
- Quick look Interpretation Summary
- Clean (Shale Free) Formation
- Shaly Formation
- Shale Distribution
- Clean Formation (No Shale)
- Shaly Formation
- Steps of Shaly Sand Analysis
- Gamma Ray Log - Shale Volume Evaluation
- Self Potential Log - Shale Volume Evaluations
- Vsh Correction- Effective Porosity Estimation
- Shale and Saturation Evaluation

- Saturation Estimations Equations for Shaly Sand
- Building Petrophysical Interpretation Model
- Cut off to Estimate Net Pay
- Well to Well Correlation: Sand Correlation
- Application of Cross-plot in Petrophysical Interpretation
- Coring Operations
- Why We Core?
- Objectives of Coring Program
- Engineering Objectives
- Geological Objectives
- Core Analysis Requirements
- Who are Concern?
- Objectives of Coring Program
- Coring Process (Planning – Goals)
- Core Quality
- Coring Performance
- High Levels of Safety
- The five part coring process
- Coring Techniques
- While Drilling
- After Drilling
- While Drilling
- Conventional Coring
- Conventional Diamond Coring
- Standard Diamond Coring
- Continuous Coring
- Inner Barrel Types
- Aluminum Inner Barrel
- Fiberglass Inner Barrel
- Sponge Core
- Extracting Core from Well
- After Drilling
- Sidewall Coring

- Percussion Sidewall Coring
- Advantages
- Disadvantages
- Summary of Coring Techniques
- Conventional Coring versus Sidewall Coring
- Wireline Coring Advantages
- Conventional Core Advantages
- Another Types of Coring
- Sleeved Coring
- Low Invasion Coring
- Gel Coring
- Oriented Coring
- Slimhole Coring
- Selection of the core type and coring fluid
- Wellsite Core Handling and Preparation
- Core Handling and Preservation at the Well Site
- Alternate Preservation Methods
- Preservation Methods - which to use and why?
- Preservation Methods - mechanical stabilisation
- Preservation Methods – environmental control
- Preservation Methods – heat-sealable plastic laminates & plastic bags
- Preservation Methods – dips and coating
- Preservation Methods – anaerobic and glass jars
- Preservation Methods – sealing within disposable inner liners, barrels or tubes
- Preservation Methods – specialised techniques for unconsolidated cores
- Concerns about Core Preservation at the Well Site
- Degree of preservation is a function of:
- Wellsite Core Gamma
- Wellsite Core Sampling and Plugging
- Laboratory Core Handling and Preparation
- Core Unpacking and Layout
- Core Orientation and Marking
- Sampling for Core Analysis

- Drilling Plugs in Consolidated Core
- Drilling Plugs in Unconsolidated Core
- Rotary Core Sample Preparation
- Samples for Core Analysis
- Sample Cleaning Prior to Analysis – Plugs and Rotaries
- Cleaning Techniques – Plugs and Rotaries
- High energy
- Low energy
- Soxhlet Cleaning Technique
- Sample Drying Techniques – Plugs and Rotaries
- Standard convection oven (common)
- Vacuum convection oven
- Humidity oven (common)
- Critical point drying
- Coring Analysis
- Objectives of Core Analysis
- Summary of Coring Analysis Objectives
- Types of Core Analysis
- Core Analysis Measurements – Plugs and Rotaries
- Saturations
- Grain Density
- Porosity
- Permeability
- Routine Core Analysis Measurements
- Conventional (Routine) Core Analysis
- Core Gamma Log
- Core Photography
- Measurements of Porosity
- Definition
- Total Porosity
- Effective Porosity
- Bulk Rock Elements
- Grain volume

- Pore volume
- Bulk Volume measured via:
- Caliper
- Calculated Vb = Vp + Vg
- Conventional (Routine) Core Analysis
- Measurements of Permeability
- General Definition
- Types
- Specific (Base) Permeability
- Effective Permeability
- Relative Permeability
- Klinkenberg Permeability
- Factors Affecting Permeability Measurement
- Gas Slippage and Lab Perm
- Gas Slippage - It's Importance
- Gas Slippage Factor vs. Pore Size
- Inertial Resistance (β)
- Inertial Resistance vs. Pore Size
- β - Its Importance
- Confining Pressure
- Reactive Liquids
- Influence of Stress on Porosity and Permeability
- Accuracy of Core Analysis Measurements
- Saturations Via Dean Stark
- Suitable samples
- Fluid Saturations - Core Analysis
- Factors affecting fluid saturations in cores
- Application of Core Saturations
- Estimating Fluid Contact Depths from Core Saturations
- Maximum Water Saturation for Oil and Gas Production
- Special Core Analysis Measurements
- Special (SCAL) Core Analysis
- SCAL Sample Protocol

- Capillary Pressure
- Capillary Pressure and K
- Why Determine Capillary Pressure?
- Capillary Pressure
- Capillary Pressure (Some Definitions)
- Drainage Process
- Imbibition Process
- The Displacement Pressure
- The Entry Pressure
- The Threshold Pressure
- Mercury Injection
- Centrifuge Technique
- Porous plate – drainage
- Wettability
- Wettability Classification
- Wettability Effects on Oil recovery
- Rock Fluid Properties
- Wettability Measurements
- Relative Permeability
- Relative Permeability Functions
- Relative Permeability Measurements
- Electrical Properties
- Formation Factor and “m”
- Resistivity Index and “n”
- Resistivity Index
- Effect of Overburden and Temperature on Resistivity
- Effect of Brine Resistivity on F
- Example - Archie water saturation, Sw
- Another Core Analysis Tests
- Additional Testing
- Percussion Sidewall Analysis
- PSCA – Summation of Fluids
- PSCA – Summation of Fluids

- Percussion Sidewall Core Analysis
- Petrology
- Unslabbed Core Description - what are we dealing with?
- Mineralogical Sample Screening - minimising the risk of laboratory induced damage
- Thin Section Petrography
- SEM
- XRD
- X-ray Scanning
- CAT Scanning
- Core Analysis Results
- Information from Cores
- Coring Analysis
- Quantifying Hydrocarbons
- Example RCA Workflow
- Example SCAL Workflow (Gas Field)
- Full Petrophysical Analysis
- Why Core and Log Data May Not Agree
- Depth control
- Core and Log Lithology
- Net Sand Definition
- Porosity Calculation
- Core and Log Porosity
- Archie Saturation
- Permeability
- Full Petrophysical Interpretation
- Reservoir Characterization Modeling and Description
- Benefits of an Integrated 3D Reservoir Model
- Reservoir Characterization Principles
- Stages of Reservoir Characterization
- Outline of Reservoir Characterization
- Themes for Successful Reservoir Characterization
- Key challenges

- How do you add value to your team (company)?
- Who are Concern?
- Petrophysics
- Seismic Interpretation and Attribute Analysis
- Geomodeling
- Volumetrics
- Role of the Geologist and Petrophysist in Reservoir Characterization Studies
- Model Types
- Static
- Dynamic
- Stochastic
- Reservoir Modeling
- Exploratory Data Analysis (EDA)
- Basic Interpretation
- Premodeling Organization
- Data Preparation and Formatting
- 3D Structural Modeling
- Stratigraphic Modeling
- Facies Modeling
- 3D Petrophysical Modeling
- Upscaling 3D Dynamic Modeling
- Flow Simulation
- Model Assumption Iteration and Updating
- Strengths of Reservoir Characterization Methodology
- Geological Modeling Tracks
- Reservoir Modeling
- Multi-Disciplinary Reservoir Characterization Workflow
- Six reasons for 3D modelling
- Sources of Data and Information
- Geological Issues
- Scales and Sampling
- Why build 3D static models?
- Fault modeling guidelines

- Reservoir layering guidelines
- Why build stochastic 3D models?
- Stochastic Modelling – what's the problem?
- 2D models, 3D models or 3D stochastic models?
- Capturing heterogeneity
- Object vs Indicator methods
- Indicator Simulation
- Why build object-based stochastic 3D models?
- Object-Based Methods
- Why do reservoir simulation?
- Engineering Issues
- The Modelling Process
- History Matching Stochastic Models