
EP005: Basin, Play Analysis, Petroleum Generation and Migration

Format and Duration
Self-Paced - 19 Hours

Summary

A package of Basin Analysis courses designed to provide geoscientists with a thorough foundation in Basin Analysis, Petroleum Generation and Migration and Play Fairway Analysis.

EC022: Basin Analysis - This comprehensive course delves into the principles and applications of basin analysis, examining tectonic processes and sediment dynamics across diverse geological settings. The eight modules cover foundational topics such as tectono-stratigraphy, sequence stratigraphy, and hydrocarbon migration, alongside tools like seismic interpretation, potential field data, and topographic information. Key tectonic environments—rift basins, passive margins, fold and thrust belts, inversion tectonics, and strike-slip systems—are explored through case studies, including the Gulf of Suez, Orange Basin, and Los Angeles Basin.

Learners will gain insights into fault propagation, sediment dispersal, structural evolution, and petroleum systems analysis. Special emphasis is placed on gravitational processes, salt tectonics, and foreland basin dynamics, with real-world applications in resource exploration. This course equips participants with an understanding of basin formation and tectonic influences on sedimentation patterns, providing critical knowledge for geoscience and petroleum engineering professionals.

EC020: Petroleum Generation and Migration - This comprehensive course delves into the principles and applications of basin analysis, examining tectonic processes and sediment dynamics across diverse geological settings. The eight modules cover foundational topics such as tectono-stratigraphy, sequence stratigraphy, and hydrocarbon migration, alongside tools like seismic interpretation, potential field data, and topographic information. Key tectonic environments—rift basins, passive margins, fold and thrust belts, inversion tectonics, and strike-slip systems—are explored through case studies, including the Gulf of Suez, Orange Basin, and Los Angeles Basin.

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EC021: Play Fairway Analysis - Play Fairway Analysis is a critical stage in hydrocarbon exploration, the fundamentals of which are covered in six modules that examine the presence and effectiveness of the main play elements: reservoir, seal, and source. The course introduces essential definitions and highlights the interplay between these elements in hydrocarbon generation, migration, and trapping. Participants will learn to identify play elements in the subsurface using techniques such as well log, seismic attribute, and seismic facies analysis.

Emphasis is placed on diagenetic processes influenced by thermal and effective stress, as well as depositional environments and sediment origin. Source rock quality is addressed through exploring

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pyrolysis techniques, with a focus on parameters such as hydrogen and production indices. Additionally, migration pathways, thermal histories, and charge timing are examined in detail. Practical insights into these complex concepts are provided through key case studies, including the Nam Con Son and East Texas Basins.

Learning Outcomes

EC022: Basin Analysis

1. Analyse tectonic controls on basin formation, including subsidence mechanisms, heat flow variations, and the influence of mantle dynamics.
2. Apply seismic sequence stratigraphy and alternative data sources (e.g., topographic and potential field data) to characterise basin structure and stratigraphy.
3. Evaluate sediment dynamics and fault propagation, including the impact of relay ramps, rift fault polarity, and extensional migration on sediment dispersal.
4. Explain the structural evolution and hydrocarbon potential of passive margins, focusing on gravity-driven processes, salt tectonics, and case studies such as the Orange Basin and the Nile Delta.
5. Assess the formation and petroleum systems of compressional basins and foreland fold-and-thrust belts, using global case studies for practical insights.
6. Understand the principles of inversion tectonics, including structural reactivation, fault geometries, and their implications for petroleum exploration.
7. Interpret the mechanics of strike-slip tectonics and their influence on basin subsidence, sedimentation, and seismic activity, using examples like the San Andreas Fault and Los Angeles Basin.
8. Integrate basin analysis concepts to predict resource potential and enhance exploration strategies across diverse geological settings.

EC020: Petroleum Generation and Migration

1. Understand the composition and compounds that make up petroleum.
2. Characterise kerogen using Organic Petrography, Elemental Analysis and Organofacies techniques.
3. Characterise source rocks using Total Organic Carbon, Rock Eval and Pyrolysis Gas Chromatography techniques.
4. Learn about hydrocarbon generation from biogenic processes, thermogenic processes and coals.
5. Calibrate thermal modelling by using Vitrinite Reflectance, Spore Colouration Index and Rock Eval Tmax techniques as maturity indicators.
6. Learn about molecular maturity methods to analyse hydrocarbons from expulsion to accumulation.
7. Understand primary and secondary migration processes and the formation of complex subsurface overpressure patterns.
8. Learn how to estimate volume and phase to predict hydrocarbon in place, to be used in volumetric and economic assessments.

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EC021: Play Fairway Analysis

1. Define and evaluate the key play elements—reservoir, source, and seal—and their roles in hydrocarbon systems.
2. Apply workflows and visualization techniques, including seismic and well log analysis, to assess the presence and effectiveness of play elements.
3. Analyse reservoir quality and effectiveness, focusing on porosity, permeability, flow rates, and diagenetic controls.
4. Evaluate seal integrity, considering capillary forces, pressure regimes, and stress impacts on hydrocarbon column height.
5. Assess source rock presence, quality, and production timing using techniques such as pyrolysis and vitrinite reflectance.
6. Explore migration pathways, basin evolution, and charge timing, emphasising carrier bed properties and thermal histories.
7. Understand how to construct Gross Depositional Environment (GDE) maps and interpret seismic facies to support exploration decisions.
8. Integrate geological and geophysical data to reduce exploration risks, applying knowledge through global case studies.

Training Method

This is a bundle of self-paced e-learning courses, totalling ~18 hours learning time. Learning materials are structured into short sections, each including interactive text and image content, animations, video, and audio. End of course quizzes are scored to provide the learner with their learning progress.

Who Should Attend

This course is aimed at geoscience and petroleum engineering professionals.

Course Content

EC022: Basin Analysis

Introduction to Basin Analysis

This module introduces basin analysis, focusing on tectonic controls on basin formation and evolution. It covers key topics like heat flow, tectono-stratigraphy, source rock properties, and hydrocarbon migration, offering foundational knowledge on mechanisms of extension, compression, and variations in passive margins for exploration and petroleum systems.

Basin Definition

Explore the use of well, seismic, topographic, and potential field data to understand basin structure and stratigraphy. This module emphasises sedimentary analysis and integrates alternative data sources, including insights from drilling projects like DSDP, ODP, and IODP, for enhanced accuracy in modelling

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basin evolution and hydrocarbon systems.

Seismic & Sequence Stratigraphic Analysis

Delve into seismic and sequence stratigraphy to predict reservoir characteristics. This module covers sequence boundaries, tectonic influences, and sea-level changes, highlighting their impact on sedimentary sequences. Applications in tectonics and petroleum systems analysis are emphasised.

Lithospheric Extension - Rift Basins

This module explores fault growth, relay ramps, and the effects of seismic events on sediment dispersal. Using case studies like Borah Peak, USA and the Gulf of Suez, it examines rift fault polarity, sediment entry points, and the impact of fault migration on sedimentation in rift basins.

Passive Margins Gravitational Collapse

Examine passive margin processes, including gravitational sliding and spreading, with case studies such as the Orange Basin, SW Africa, and the Nile Delta. The role of salt tectonics in trap formation is highlighted, alongside insights into structural configurations and hydrocarbon reservoir development in key global regions.

Compressional Basins

Focus on the structure and dynamics of compressional basins and foreland fold-and-thrust belts. This module explores foreland basin formation, fault development, and sediment dispersal, using case studies from Europe, the Middle East, and South America to analyse hydrocarbon reserves in compressional settings.

Inversion Tectonics

Discover the reactivation of extensional basins under compression in this module. Structural inversion, fault geometries, and intraplate deformation are explored through real-world examples and sandbox modelling, providing insights into petroleum prospectivity and structural evolution.

Strike Slip Tectonics

Learn about strike-slip fault mechanics, associated features, and their influence on basin subsidence and sedimentation. This module uses examples like the San Andreas Fault and Los Angeles Basin to examine geological formations, seismic activity, and the role of strike-slip tectonics in petroleum systems.

EC020: Petroleum Generation and Migration

Petroleum Generation and Migration - Introduction

This module provides an overview of geochemical principles used in the petroleum industry. It will cover how petroleum is formed and look in detail at petroleum compounds. Participants will also learn about phase, the importance of phase with respect to hydrocarbon accumulations and how to interpret a petroleum phase diagram.

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Source Rocks

This module teaches about kerogen formation and classification. Learners are introduced to the techniques used to characterise kerogen and source rocks and learn how to identify source facies and potential. Finally, the module looks at total soluble extracts and the saturate gas chromatograph.

Generation and Expulsion Processes

This module starts by introducing learners to Methanogenic Archaea and looks at their role in biogenic gas formation, the effect of temperature control and biogenic gas volumetrics. Various biogenic gas case studies will be considered. The module then moves onto thermogenic processes with respect to hydrocarbon generation and considers expulsion and accumulation. Finally, learners will gain an appreciation of gas generation from coals.

Maturity Measurements

This module explores the three measurement types used in thermal modelling, including vitrinite reflectance, spore colouration index and rock eval Tmax. The learner will develop an understanding of the methods and uses of each technique along with an appreciation of the respective advantages and disadvantages. The module then looks at molecular maturity techniques and the common molecular reactions. Finally, the fragmentogram and its analysis will be introduced.

Petroleum Migration

The final module in this course considers petroleum migration. The learner will develop an understanding of the causes of overpressure and the formation of complex overpressure patterns using the North Sea Brent Province as a case study for pressure transmission. How to calculate the petroleum fluid potential and the effect on seal capacity, particularly with respect to the maximum petroleum column height will be shown. The second half of the module looks at secondary migration and petroleum losses. The effect of faults will be considered as the learner gains an appreciation of migration path and trapping. Finally, this module will explain how to estimate volume and phase to assist volumetric calculations and economics.

EC021: Play Fairway Analysis

Introduction and Overview of Workflow

This module introduces Play Fairway Analysis, covering definitions, visualisation techniques, and workflows. Using the Exploration Triangle, introduced workflows assess reservoir, source, and seal presence and effectiveness, as well as trap domains and resource estimates. Practical examples, like the Northern North Sea Petroleum Province, illustrate play definitions and evaluation processes.

Reservoir and Top Seal Presence

This module covers reservoir and top seal presence, focusing on clastic reservoir identification through GDE mapping, sequence stratigraphy, seismic facies, and attribute analysis. It emphasizes the importance of top seals for hydrocarbon trapping, highlighting identification techniques like lithological analysis, well logs, and seismic mapping.



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Source Presence and Quality

This module explores source rock presence and quality, focusing on factors like organic richness, thickness, and petroleum yield. It covers classification schemes, global case studies, and evaluation techniques such as well logs and pyrolysis. Topics include kerogen kinetics, depositional environment influences, and the generation and limitations of biogenic gas systems.

Reservoir Effectiveness

This module examines reservoir quality and effectiveness in clastic systems, focusing on porosity, permeability, and economic flow rates. It explores controls like sediment provenance, depositional environments, and post-depositional processes, emphasising effective and thermal stress. Key pressures and pore pressure plots are examined in detail, using examples like the Skagerrak field.

Top Seal Effectiveness

This module explores seal effectiveness, focusing on capillary and hydrodynamic seals, key pressures, and hydrocarbon migration. Key topics include capillary entry pressure, pressure regimes, fluid density, and controls on column height. Case studies, such as the Haltenbanken region, illustrate seal integrity, pressure dynamics, and migration pathways for hydrocarbons.

Source Effectiveness

This module focuses on hydrocarbon generation and migration, influenced by thermal history, basin geometry, and relative timing. Key topics include maturation, carrier beds, charge styles, and migration dynamics. Techniques like burial history modelling and case studies, such as the Western Black Sea, illustrate how basin evolution informs hydrocarbon exploration.