Carbonate Reservoir Geology

Instructor:
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Who should attend:
Petroleum geologists, explorationists, petrophysicists, geophysicists and engineers involved with exploration of carbonate plays and development of carbonate reservoirs. Previous knowledge of carbonate sedimentology is not required.

Overview:
This course is designed to develop skills in understanding the geometry and petrophysical characteristics of carbonate reservoirs. Depositional fabric, grain type and size and subsequent diagenetic modifications are the major controls on carbonate reservoir behaviour. The complex inter-relationship of the depositional and burial history can be unravelled to allow prediction of reservoir facies and reconstruction of three-dimensional reservoir models. Sequence stratigraphy is a powerful framework for modelling and predicting the distribution of carbonate and evaporite reservoirs and seals. The course demonstrates the value of the reservoir model in volumetric assessment and development of carbonate reservoirs. Extensive practical sessions can utilise the client’s own data or Robertson’s non-exclusive data.

Key learning objectives:
- Understand carbonate depositional systems and controls
- Recognise and model controls on reservoir quality and pore systems, including diagenesis and fracturing
- Understand and apply carbonate and evaporite seismic stratigraphy and sequence stratigraphy.
- Interpret log responses

Day 1

Introduction to Carbonate Sedimentology:
- Environmental factors controlling carbonates
- The carbonate factory and complexity of pore systems
- Regional variations in distribution

Exercise: - Predict areas of likely carbonate deposition

Constituent Components of Carbonates
- Carbonate mineralogy
- Skeletal grains
- Non-skeletal grains
- Carbonate mud

Exercise: - Identify different carbonate grains using thin sections and core pieces

Environmental Analysis
- Classification of carbonates
- Ichnology and ecology
- Carbonate facies and depositional models

Exercise: - Place thin section photographs in their appropriate depositional environment

Exercise: - Identify environment of deposition for given thin sections using understanding of controls on distribution and textures

Classification Of Carbonate Platforms
- Platform models
- Shelf/ramp models
- Other platform models
- Genetic classification of platforms
Day 2

Understanding Depositional Environments and Predicting Petroleum Systems

Elements
- Paleogeographies and depositional evolution

Aeolian And Lacustrine Facies
- Aeolian facies characteristics
- Economic importance
- Lacustrine facies characteristics
- Economic importance

Sakka and Tidal Flat Depositional Model
- Peritidal environments
- Sabkha diagenesis
- Reservoir potential
- CASE STUDY: Sabkha reservoirs in the UAE

Exercise: - Using given information, interpret and sketch depositional and diagenetic models
Exercise: - Develop a model to show understanding of the depositional system affecting a carbonate reservoir

Barrier Shoals and Lagoons
- Shelf facies in core and thin-section
- Shelf facies diagenesis
- Reservoir potential

Exercise: - Locate depositional environments on a given cross section
Exercise: - Locate core descriptions on the cross section in their correct depositional environment
Exercise: - Analyse a wireline log response, giving locations of depositional environments

Day 3

Reef Models and Play Types
- General characteristics and classification
- Processes controlling formation
- Reef diagenesis
- Reservoir potential
- UAE rudist reef reservoirs

Exercise: - Determine depositional facies of thin section samples
Exercise: - Construct a facies cross section through the logs given using this data
Exercise: - Interpret results with respect to development of reservoir facies

Pelagic And Redeposited Carbonates
- Pelagic/planktonic sediments
- Redeposited sediments
- Diagenesis
- Reservoir potential

Exercise: - Establish a depositional and diagenetic model for an area based on data given
Exercise: - Identify areas with the best reservoir potential

Carbonates Through Time
- Changes through time
- Example of reef development in Middle East
- Patterns of evolution through time
- Responses to sea level variation
- Impacts on reservoir quality and architecture
Diagenesis And Fracturing
- Carbonate mineralogy
- Porosity: creation, reduction, changes and trends
- Karstification and other mineral cements

**Exercise:** Identify pore types and diagenetic effects, making an assessment of permeability

**Exercise:** Identify trends in sedimentology and porosity

**Exercise:** Identify possible seal/reservoir units and mark locations of wells to be drilled

Day 4

Karstic

Plays
- Features of subaerial exposure, karst and caliche
- Recognition of surfaces using seismic and logs
- Example – Western Mediterranean

**Sequence Stratigraphy - Basic Concepts and Application**
- Facies analysis and lithostratigraphy
- Chrono and biostratigraphy
- Seismic and sequence stratigraphy

**Exercise:** Examine the Zechstein sequences of the UK Southern North Sea, marking systems tracts, sequence boundaries and potential reservoirs

**Exercise:** Label seismic lines with systems tracts and sequence boundaries, suggesting likely environments of deposition and reservoir units

**Carbonate And Evaporite Sequence Stratigraphy – Principles and Application**
- Principles of carbonate sequence stratigraphy
- Principles of evaporate/carbonate cycle sequence stratigraphy

Day 5

**Carbonate Seismic Stratigraphy – Principles and Application**
- Principles of seismic stratigraphy
- Examples of carbonate sequences on seismic

**Integrating Well Data**
- Rock data – cuttings and cores (sedimentology, analysis and SCAL)
- Wireline logs
- Well testing and the roles of specialists

**Carbonate Reservoirs**
- Variety of pore types and relation to permeability
- Fracture porosity
- Wettability and capillary pressure
- Reservoir examples – West Africa Albian Dolomites and North Sea Chalk

**Exercise:** Compare core and wireline logs, establishing a reservoir layering scheme

**Exercise:** Use the logs to identify lithology and distribution of units

**Exercise:** Use porosity/permeability cross-plots to determine net porosity and sand thicknesses to create a contour map of net sand thicknesses