

## N310: Carbonate Reservoir Characterisation and Modelling (*Provence, France*)

Instructor(s): Mark Bentley and Richard Oxlade / Ed Stephens

Format and Duration

Field - 5 Days

Low Physical Demand

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### Summary

**Business Impact:** The bulk of the world's oil and gas resources are in carbonate reservoirs, so **forecasting productivity** in carbonates is fundamental to our business; This course makes the link between **reservoir characterisation** and **how fluids flow** in these heterogeneous reservoirs, unravels some of the **reasons why our forecasts are often incorrect**, and offers guidance on how to **improve** those **forecasts**.

Using analogue outcrops in the Luberon and Cassis area of Southern France, this course develops workflows for characterisation and modelling in carbonate reservoirs, covering in particular the issues of conceptual reservoir characterisation, the handling of scale, and the representation of fracture detail in cellular models. The outcrop section is a direct analogue for Shuaiba/Kharaib Middle East reservoirs, including high and low energy areas of rudist platforms, inner and outer shelves, and chalks. The modelling principles are transferable to other carbonate environments.

### Learning Outcomes

Participants will learn to:

1. Characterise a carbonate reservoir in terms of essential reservoir elements and describe the architectural arrangement of those elements.
2. Evaluate reservoir property distributions for those elements in a form suitable for input to static/dynamic reservoir modelling.
3. Judge the scale at which a static/dynamic modelling exercise should be conducted, including any need for multi-scale modelling.
4. Prepare rules of thumb for effective property modelling in carbonates at a range of scales.
5. Assess fracture systems in carbonates and explain the options for modelling them (explicit DFN vs. implicit effective properties).
6. Apply the concept of representative elementary volumes (REV) to fractured and unfractured carbonates.
7. Analyse the seismic expression of large scale outcrops based on underlying cellular model description.
8. Evaluate the issues governing well placement in carbonates under a range of conditions.
9. Propose an optimal development plan for a carbonate reservoir under a range of contrasting fluid fills.

### Training Method

A five-day field-based course based in Provence, Southern France. The event will be conducted wholly in the field. Outcrop-based reservoir models and forward-modelled seismic will be used to support discussion. The focus will be on experiential learning with mixed-discipline group-based tasks. Short talks will be given at the outcrop and simple calculations demonstrated using rules-of-thumb to assist analysis. This course will make use of Digital Outcrop Imagery (DOI).

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### Physical Demand

The Physical demands for this class are LOW according to the Nautilus Training Alliance field course grading system. This class requires a basic level of fitness. Field locations are all easily accessible requiring only a short walk from the vehicles. The longest walk is approximately 0.5 km along a road section. There will be a boat trip (weather dependent) to view key cliff exposures that can only be seen from offshore (approx. 1 hour duration).

### Who Should Attend

The course is aimed at a cross-discipline audience including reservoir engineers, geoscientists, petrophysicists, and others involved in carbonate reservoir appraisal and field development. This field course is recommended for multi-disciplinary team attendance.

### Prerequisites and Linking Courses

Knowledge of reservoir modelling and simulation is assumed to at least awareness level.

Linking courses that may be of interest include D020 (Carbonate Depositional Systems: Reservoir Sedimentology and Diagenesis (Distance Learning)), D073 (Integration of Sedimentology, Petrophysics and Seismic Interpretation for Exploration and Production of Carbonate Systems (Distance Learning)), and D427 (Reservoir Model Design (Distance Learning)).

### Course Content

Carbonate reservoirs are often poorly-modelled and the distinction between workflows for carbonates and clastics missed. The lack of clear  $k/\phi$  relationships in carbonates distinguishes them from their clastic counterparts, and fractures in particular can be difficult to model without convoluted workflows. The course tackles these issues and gives practical advice on how to model these reservoirs.

Reservoir modelling schemes are applied to contrasting analogue outcrops, covering environments ranging from inner to outer platforms through shelf to proximal basin, including a spectacular karstified fracture system. The outcrops selected are age-equivalent analogues for Middle Eastern Shuaiba/Kharaib carbonates on the opposing side of Tethys. Specialist interpretative input to the course is provided by Jean Pierre Masse from the University of Marseilles, an authority in his field.

Topics covered include:

- Carbonate reservoir characterisation
- Fracture characterisation
- Model scale and upscaling
- Representative elementary volumes in carbonates
- Seismic forward modelling in carbonates
- Well placement
- Simulation and forecasting in carbonates

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The following proposed itinerary is designed as a guide only:

### Day 0: Arrival

Arrival in Marseilles, transfer to Gordes.

### Day 1: Orgon - Lateral Homogeneity

### Day 2: Rustrel - Lateral Heterogeneity

- Small-scale k heterogeneity
- Handling scale
- Thief zones
- Forecasting water breakthrough

### Day 3: La Nesque - Large Scale Architecture

- Gross architecture
- Imaging on seismic
- Coning behaviour
- Large scale vs. small scale models

### Day 4: Cassis - Fractures and Karst

- Damage zone architecture
- Matrix vs. fracture flow
- Modelling fractures
- Completion options

### Day 5: Cassis - Carbonate Model Design

- Sector model design
- Scenarios

### Day 6: Departure