

## N059: Carbonate Systems and Facies Architecture: Exploration and Reservoir Implications (*Mallorca & Menorca, Spain*)

Instructor(s): Juan Ignacio Baceta & Guillem Mateu

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### Format and Duration

Field - 5 Days  
Moderate Physical Demand

## Summary

Business Impact: The key learnings from this course can be applied **throughout the E&P life-cycle** to better **predict carbonate reservoir potential**, conduct **volumetric assessments** with greater confidence, and ultimately create **more robust reservoir models**.

This course provides an in-depth understanding of the controls on the development of carbonate successions using a process-product approach. The dominant influences of biota and sea level change on the facies, architecture, and reservoir characteristics of ramp and reef systems are examined. Participants develop an understanding of the processes driving carbonate systems that helps to reduce uncertainties in the prediction of subsurface facies and porosity distribution.

Excellent exposures of the Upper Miocene platforms along continuous outcrops on the sea cliffs of the Balearic Islands, as well as water-well data, reveal in detail the 3-D facies belts distribution in two types of carbonate platforms - a distally-steepened ramp and a reef-rimmed platform. In these examples, most of the detailed stratigraphic heterogeneities are below the resolution of seismic and well-log analyses. Thus, they could aid in constructing realistic models for distribution, geometry, and volume of porous and permeable units of some shallow-water carbonate reservoirs, as well as models for fluid flow.

## Learning Outcomes

Participants will learn how to:

1. Sketch the stratigraphy and evolution of Upper Miocene carbonate ramp to reef sequences in the Balearic Islands (at Basic Application level).
2. Evaluate the underlying biological and hydrological controls that determine carbonate deposition in reef and ramp settings.
3. Compare and contrast the controls on carbonate versus siliciclastic deposition.
4. Evaluate the effects of sea level change on the architecture and geometry of carbonate platforms.
5. Assess the relationship between the carbonate factory and accommodation space - in particular examine the effects of the location and volume of sediment production, biological binding and early cementation.
6. Characterise the key sedimentological aspects and facies belt distributions in ramp and rimmed shelf carbonate systems and assess likely primary porosity distributions.
7. Appraise interpretations of carbonate platforms from seismic data and likely facies distribution.

## Training Method

This is a field course, comprising a mixture of observation, discussion and exercises in the field, supported by short classroom sessions.

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### Physical Demand

This course is graded MODERATE on the Nautilus Training Alliance field grading system. Fieldwork is conducted primarily on coastal sections, involving walking and scrambling over deeply weathered, highly uneven, and sharp carbonates. Many outcrops are adjacent to precipitous sea cliffs, which could cause concern for those with vertigo. Each day typically consists of multiple hikes, each under 2 km (1 mile) in distance, with the longest hike being 4 km (2.5 miles) long. One field stop involves a 500 m (0.3 mile) walk down a zig-zag foot trail with a 100 m elevation change from top to bottom and then back up again. Weather conditions are generally warm, but high heat, high humidity, rain, and cool conditions are possible. Transport will be by coach on paved roads.

### Who Should Attend

This course is designed for all subsurface geoscientists who wish to broaden and deepen their knowledge of carbonate plays. Attendance on this course could also benefit reservoir engineers, team leaders and managers looking to better understand carbonate reservoir facies and porosity distribution and how these impact hydrocarbon in-place volumes, as well as production behaviour.

### Prerequisites and Linking Courses

There are no prerequisites for this class although some experience of carbonate systems is an advantage, such as that acquired from Nautilus Training Alliance course N020 (Carbonate Depositional Systems).

### Course Content

#### Day 0 (Menorca Island)

*Participants arrive in Menorca.*

#### CLASSROOM:

- Safety brief
- Course introduction

#### Day 1 (Menorca Island).

FIELD: The Lower Tortonian ramp system. Observation of inner- and middle ramp lithofacies, including:

- Examination of the transition from continental to marine conditions and inner to middle ramp facies.
- Grain size and textures distribution
- Dune bedforms and palaeocurrent directions
- Diagenesis: Fluid flow pathways evidenced by preferential cementation

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**CLASSROOM:**

- Overview of the Lluçmajor reef rimmed Platform.

**Day 2 (Menorca Island)**

**FIELD:** The Lower Tortonian ramp system. Observation of ramp-slope and outer-ramp lithofacies, including:

- Rhodolithic facies composition and arrangement. Loci of carbonate production
- Toe of slope facies and subaqueous dunes: types and transport direction
- Mass-flow- and turbidity-flow deposits on the ramp slope; channel and levee structures
- Slump scars and backsets and density flows
- Discussion on implications for reservoir potential

*Fly to Mallorca and Hotel check-in*

**Day 3 (Mallorca Island)**

**FIELD:** The upper Tortonian reef rimmed shelf. Observation of a complete set of representative facies, including:

- Open platform and reef slope lithofacies. Changing style of sediment production
- Reef core lithofacies, with representative core ecological-bathymetric zones, porosity types and diagenesis
- Outer lagoonal lithofacies. Grainy and bioconstructed facies interrelationships

**Day 4 (Mallorca Island)**

**FIELD:** The Upper Tortonian reef rimmed shelf. Analysis of the architecture of the Lluçmajor shelf and exercises, including:

- Boat trip to view the shelf to basin transition, from Vallgornera - Cala pi to Cap Blanc (9 - 20 stops) (It may change day, depending on sea conditions)
- General architecture, statal geometries and sequence development from the large- to the meso-scale

**EXERCISES (in the field):**

- Core description exercise on cores drilled from the Miocene platform
- 2D core correlation exercise
- Discussion on 3D core correlation: applications to seismic interpretations

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**Day 5 (Mallorca Island)**

FIELD: Upper Tortonian-Messinian capping series and paleokarst. Analysis of the Santanyi Limestone outcrops and facies succession, including:

- Observation of mangrove deposits, tidal grainstones, thrombolites and stromatolites
- Karst collapse structures, implications for porosity development
- Sequence stratigraphic features and their influence on hydrocarbon exploration and development in carbonate systems

**Day 6**

*Participants depart Mallorca*