

## N143: Advanced Concepts in Carbonate Exploration and Reservoir Characterisation (*Northern Spain*)

Instructor(s): Paul Wright, Giovanna Della Porta, Juan Ignacio Baceta, Juan Bahamonde and Mikel Lopez-Horgue

---

### Format and Duration

Field - 6 Days  
High Physical Demand

### Summary

This advanced carbonates field course analyses a series of outstanding outcrops to examine modern concepts in carbonate reservoir geology. Three principal themes are: the nature of carbonate shelf architecture (with specific analogues for PreCaspian Palaeozoic carbonates) through a seismic-scale outcrop transect; hydrothermal dolomite plays and their structural controls; and shelf geometry and mixing-zone palaeokarstic porosity associated with third-order sea level changes.

### Learning Outcomes

Participants will learn to:

1. Characterise different lithofacies and their distribution in lower slope, upper slope, outer and inner platform in a microbially dominated carbonate platform of Upper Carboniferous age and construct a depositional model.
2. Compare the geometries observed in the Sierra del Cuera platform with seismic-scale features from the subsurface.
3. Assess the reservoir potential of the Upper Carboniferous of the Sierra del Cuera and compare with other microbially-dominated carbonate platforms and dissimilar coralgal reef systems.
4. Characterise the platform interior cyclicity in icehouse system and compare and contrast icehouse vs. greenhouse interiors in terms of reservoir architecture.
5. Perform field observations of stratal patterns, depositional geometry and lithofacies distribution and apply to reservoir modelling of PreCaspian reservoirs.
6. Assess the products and debate the processes involved in hydrothermal dolomite (HTD) formation, and the importance of fault-related fluid flow and porosity development.
7. Appraise the stratigraphic architecture of seismic-scale Paleogene carbonate platform systems, including coral-algal reefs and slopes, and relate this to 2nd order sea level cycles and long-term variations in shallow carbonate factories (from Paleocene coralgal reef-rimmed shelves to Eocene larger foraminifer-dominated ramp systems) and the application of this knowledge to understand subsurface reservoir examples in North Africa and the middle East.
8. Assess in terms of facies, distribution and reservoir properties the early reflux dolomitisation processes affecting the interior of a layered greenhouse shelf, and comparison with classic reflux dolomite models established in Ordovician, Devonian and Permian platforms from North America.
9. Characterise at outcrop scale the key porosity types of a shelf-edge macroporosity palaeokarst system developed following a 3rd order lowstand, with evaluation of their spatial distribution, interrelationships and the inferred genetic paleohydrological model.
10. Evaluate the variations in macroporosity development in different palaeokarstic reservoirs, and how these impact upon development strategies, well location, well types and completion strategies.

---

## N143: Advanced Concepts in Carbonate Exploration and Reservoir Characterisation (*Northern Spain*)

Instructor(s): Paul Wright, Giovanna Della Porta, Juan Ignacio Baceta, Juan Bahamonde and Mikel Lopez-Horgue

---

### Format and Duration

Field - 6 Days  
High Physical Demand

### Training Method

A six-day field course to northern Spain (Picos de Europa, Cantabrian Mountains and Sierra de Urbasa). Training will be field based with ample time for general discussions. Oil field analogues will be integrated into the discussions to enhance the utility of the course.

### Physical Demand

The physical demands of this class are graded HIGH according to the Nautilus Training Alliance field grading system. The field areas are at moderate altitudes in northern Spain (~1000m) and some participants may experience unexpected fatigue or shortness of breath. The longest walk is approximately 8 km (5 miles) on trails that are steep and uneven underfoot in a mountain environment. There are walks up to 6 km (4 miles) on several days. Participants can expect both hot and cold conditions and should be well prepared for wet weather.

### Who Should Attend

This advanced course is principally aimed at experienced carbonate workers who will benefit most from discussion of the concepts presented with the tutors and their peers. If you have a reasonable understanding of carbonate systems you will be able to further develop your skills with this in-depth look at shelf configurations and different secondary porosity models. The course will be particularly useful to those involved in exploration but also aspects of reservoir modelling of HTD and palaeokarst systems will be emphasized.

### Prerequisites and Linking Courses

It is assumed that participants are familiar with carbonate systems. There are no formal prerequisites but attendees are expected to have some experience with carbonate reservoir systems in either exploration or development.

In the absence of workplace experience, attendance on the Nautilus Training Alliance classroom course N020 (Carbonate Depositional Systems: Reservoir Sedimentology and Diagenesis) followed by a field class such as N059 (Applied Carbonate Geology: Carbonate Facies and Reservoirs, Mallorca, Spain) or N091 (Carbonate Reservoir Architecture and Applied Carbonate Sequence Stratigraphy, West Texas, USA) provide suitable primers to this course.

### Course Content

**Part 1** – Carbonate Shelf Architecture: walking from the platform down into the basin. The Sierra del Cuera area of the Cantabrian Mountains illustrates the development, from seismic-scale outcrops, of an Upper Carboniferous carbonate shelf system. This part of the course involves a transect from the platform interior (including examining facies continuity and geometry) across the actual margin and down the slope examining clinofolds and toe of slope facies. Although this part of the course provides a spectacular opportunity to examine general issues about shelf carbonates, it will be especially useful to

## N143: Advanced Concepts in Carbonate Exploration and Reservoir Characterisation (*Northern Spain*)

Instructor(s): Paul Wright, Giovanna Della Porta, Juan Ignacio Baceta, Juan Bahamonde and Mikel Lopez-Horgue

---

### Format and Duration

Field - 6 Days  
High Physical Demand

those involved in the PreCaspian carbonates of Kazakhstan.

**Part 2** – Cretaceous hydrothermal dolomites of the Karrantza valley: the hydrothermal dolomite (HTD) play concept is of major interest for Palaeozoic basins in North America (Slave Point, Trenton-Black River) but also in parts of the Middle East and offshore India. This part of the course will use outstanding outcrops to review the key concepts of this important play type.

**Part 3** – Understanding palaeokarstic porosity associated with 3rd order sequence boundary: Danian Palaeokarst Systems of the Urbasa-Andia area, Navarra, north Spain. The spectacular Danian (Paleocene) shelf carbonates in this area provide the opportunity to discuss and examine at first hand how porosity develops due to lowstand processes across a shelf transect deep into an ancient shelf interior. Themes include the shelf geometry of a coral-algal system, platform margin fracture zones, cave systems, and how meteoric discharge and sea water mixing creates changes in macroporosity types.

### Course Itinerary

#### Day 0

Participants arrive at Asturias airport, transfer to Arenas de Cabrales.

#### Day 1 and 2

Fieldwork examining a Pennsylvanian microbially-dominated carbonate platform in the Sierra del Cuera. Observations will be made at both seismic and reservoir scale at coastal and mountain outcrops. Based in Arenas de Cabrales.

#### Day 3

Transfer from Asturias to Pais Vasco. En route examine a fracture-hosted dolomite body in a Cretaceous platform margin, Cantabria. Overnight Vitoria-Gasteiz.

#### Day 4 and 5

The Danian carbonate platforms in the Urbasa-Andia area, Navarra and the development of palaeokarstic porosity associated with sea level lowstands. Based in Vitoria-Gasteiz.

#### Day 6

Evolution of early Tertiary platforms into carbonate ramp systems. Travel to Bilbao.

#### Day 7

Participants free to depart Bilbao.