N028: Sand-rich Turbidite Systems and Megaturbidites: From Slope to Basin Plain. Facies, Stacking Patterns and Controlling Factors *(Pyrenees, Spain)*

Instructor(s): Henry Pettingill, Eduard Remacha and Luis Pedro Fernandez

6 Days	Competence Level: Skilled
Field Course	
Classroom Elements	
LOW	Low Physical Demand

Summary

This course studies deepwater clastic deposits in the Ainsa and Jaca Basins. Shelf-slope-basin relations are examined in detail and reveal features such as: ponding in sub-basins; system architecture; reservoir stacking patterns in a confined setting. Identification of facies types is emphasised at both reservoir and exploration prospect scales. Subsurface analogs are discussed. Participants are encouraged to discuss their own data with the class.

Learning Outcomes

Participants will learn to:

1. Evaluate the controls on deepwater deposystems and gravity-driven flow processes in a confined basin setting.
2. Evaluate genetically linked facies deposited by submarine gravity flow processes and predict their up- and down-slope expression.
3. Characterise the geometry and scale of sand bodies and their stacking patterns in outcrop and compare with reservoir units in analogous subsurface settings.
4. Appraise models for mini-basin or partitioned basin sedimentary infill and assess the effects of syndepositional tectonics on that fill.
5. Judge the lateral and vertical continuity and connectivity of slope channel, levee, base of slope and basin plain sand bodies and how analogous reservoir units might compare in the subsurface.
6. Assess high-frequency cyclicity recorded in the sediments and relate these patterns to intrinsic and extrinsic basin controls.
7. Evaluate the geometries of deepwater sand bodies and how this might affect reservoir performance.
8. Appraise the scale and significance of large-scale, basin margin failure and how such events can be used to constrain basin-wide correlations and determine basin fill architecture.

Duration and Training Method

A six-day field course in the central Spanish Pyrenees, Northern Spain. The course consists of lectures and discussion in the field, supplemented by classroom exercises. 3D models of the basin infill and deep marine deposition will be shown. Attendees are also encouraged to bring their own data for discussion as either presentations or as posters. Proportion of field to classroom time is around 70:30

Physical Demand

The physical demands for this class are LOW according to the Nautilus Training Alliance field course grading system. Travel between outcrops will by small coach and there are several short hikes of 2 – 3 km

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(1.25 - 1.8 miles) over uneven ground, but nothing overly strenuous. The weather can be highly variable and range from hot and dry to cold and very wet, please be prepared. Field days start around 9 am and finish at 7 to 8 pm (please note that meals are taken rather late by North American and northern European standards).

Who Should Attend

Geologists and geophysicists who require an understanding of deepwater clastic reservoir distribution and prediction. Engineers and geoscientists with an interest in the controls on reservoir architecture and compartmentalisation. Asset teams working in deepwater systems have found the course to be a very useful stimulus to internal discussions concerning their own reservoirs.

Prerequisites and Linking Courses

There are no prerequisites for this course but an understanding of sedimentary processes and familiarity with clastic reservoirs are helpful. Precursor classes might include general sedimentology classes such as N155 in the classroom.

This class is one of an extensive suite of deepwater clastic field courses in the Nautilus Training Alliance portfolio, each of which addresses a different system or a different aspect of deepwater systems. They are located in the French Alps (N112, N252), the Spanish Pyrenees (N028), Turkey (N102), the Karoo of South Africa (N107), Ireland (N009), and the USA (N315, N247). The geomorphological and seismic expression of deepwater systems are examined in the classroom course N072.

Course Content

This field trip will visit spectacular outcrops of Eocene turbidite systems of the Central Pyrenees that have been used by numerous petroleum companies and research organizations as analogs to model productive oil and gas reservoirs. The Hecho Group offers one of the best-exposed systems of deep marine clastics in a confined minibasin setting (foreland basin).

The field area is within a foreland basin in front of the fold and thrust belt and consists of small, partitioned, piggyback basins above the main regional detachments. These thrusts were active during deposition, hence the analogy to salt minibasins and other partitioned passive margin basins with syntectonic depositional ponding. Preserved sediments show syntectonic depositional features of infill geometries.

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Depositional systems are exposed in laterally extensive and correlatable outcrops that progress from slope feeders, canyons, channels and their related overbank deposits, channel-lobe transition, sheet-like lobes and finally, basin plain sheet systems. Some of the exposures are seismic-scale, and the integration of fieldwork, subsurface, and rock data has allowed individual beds and sand packages to be correlated over tens of kilometers, with visible facies changes from each of the depositional components deepwater systems.

Distinctive and thick carbonate megabreccias (megaturbidite beds), derived from the flanking margins of the foredeep, have been mapped amongst the turbidite depositional systems, with some traced along an extension of nearly 200 kilometers. They will be examined during the latter part of the trip highlighting their role as gas reservoirs (Serrablo Gas field).

The field course will integrate high-resolution measured sections, bed-by-bed correlation cross-sections traced along tens of kilometers (in both strike and dip) and detailed geological mapping are all integrated in order to interpret the individual outcrops and their placement in the basin-scale depositional framework. This approach will be useful to exploration and production problems from basin to reservoir scales, bringing together a wide range of facies, beds and stacking patterns that characterize the different elements of a turbidite system.

Objectives of the class are to:

- Recognize deepwater facies and stacking patterns within a partitioned foredeep, from slope to basin plain.
- Recognize key controls on reservoir production characteristics (reservoir architecture) and their predictive aspects.
- Understand the transitions from the various components of the system (channel, lobe, etc.), their controls and predictive aspects.

Key Aspects

1. Controls on deepwater depositional systems, and their identification by diagnostic criteria: from the shelfal source area, to slope feeder systems, channel to lobe deposition, overbanks, and basin floor sheet sands. Both process-related and morphological recognition criteria will be employed.
2. The relation between syndepositional tectonics and partitioned minibasins that act as receiving basins. Predictive models for the infill of facies and stacking patterns based on the interplay between minibasin geometry/development and sediment infill.
3. Gravity flow processes and products, their recognition interpretation.
4. The role of ponding in deflecting and reflecting turbidite flows on the basin floor; associated processes, depositional products and control on reservoir characteristics.

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5. The Roncal-Fiscal megaturbidite, which extends throughout the downdip basin, will be examined in outcrop and via subsurface data (where it produced as a gas reservoir).
6. Recognizing equivalent systems in the subsurface and their depositional components; anticipating lateral changes within those systems, and the production characteristics of the various facies and depositional elements.

Itinerary

Day 0:

Participants arrive in Barcelona, travel to the Ainsa region (approximately 3.5 hours by coach).

Day 1:

Introductory lectures, depart for the field area. Afternoon field excursions to examine the tectonic setting and feeder systems to the Ainsa and Jaca basins.

Day 2:

Feeder canyons and slope channel system and discussion of exploration and production implications. Evening lectures and discussion.

Day 3:

Lower slope systems, overbank/levee facies and frontal splay complexes. Evening lectures and discussion.

Day 4:

Channel-lobe transition and sheet-like lobes, influence of growing structures. Evening lectures and discussion.

Day 5:

Channel-lobe transition and sheet-like lobes - down-slope evolution to the basin plain. Group moves from Ainsa area to Jaca.

Day 6:

Megaturbidites and basin plain facies, field locations in the Jaca basin. Late return journey to Barcelona,

overnight Barcelona.

Day 7:

Depart Barcelona.