TETRA TECH RPS ENERGY | TRAINING

N156: Clastic Depositional Systems in a Basinal Framework: Exploration and Reservoir Implications *(Pyrenees, Spain)*

Instructor(s): Miguel Lopez and Pau Arbues

Format and Duration

Field - 6 Days
Low Physical Demand

Summary

A field course analysing the distribution, architecture, internal characteristics, and reservoir quality of sandstone bodies from a wide range of clastic depositional environments. The depositional settings examined occur in two regional scale sediment transport paths and include alluvial fan, fluvial, tidal- and wave-dominated shorelines/shelves and deepwater (within a well constrained basinal framework). Emphasis is on the spatial distribution of different depositional settings as controlled by the basinal framework, and reservoir attributes of sandstone bodies in different settings.

Learning Outcomes

Participants will learn to:

1. Interpret the sedimentology, stratigraphic architecture and reservoir potential of alluvial fan, fluvial, tidal- and wave-dominated shorelines/shelves, and deepwater deposits.
2. Analyse regional scale sediment transport paths in terms of their reservoir potential, the controls that determine length scales of down-dip changes along the transport paths, and predictions that can be made in terms of reservoir presence and characteristics.
3. Distinguish between small-scale, locally sourced and regional scale, distantly sourced alluvial systems and their reservoir potential.
4. Establish the spatial distribution of tidal sandstone bodies in a basinal framework and assess the nature of permeability barriers and baffles in the bodies.
5. Interpret a range of deepwater sandstone bodies from slope canyons, through basin floor channels to basin plain settings.
6. Relate the spatial distribution of reservoir potential to the structural geometry of tectonically active basins in an exploration sense.

Training Method

This is a six-day field course in the Spanish sector of the Tertiary basins in the Pyrenean mountain belt, comprising field examination of depositional systems at both seismic and, more commonly, sub-seismic, sandstone body scale. Consideration of correlation strategies in a wide range of depositional systems will be an important theme. The proportion of field time to classroom time is approximately 90:10. This course will also make use of Digital Outcrop Imagery (DOI).

Physical Demand

The physical demands for this class are LOW according to the Nautilus Training Alliance field course grading system. Access to the outcrops is easy with the majority being roadside stops. The longest walk on the field course is approximately 3 km (1.8 miles) along a hillside track and across scrubby hill land. Other short walks of up to 0.25 km (.01 miles) take in scrubby hill land and dry stream beds. Participants

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should be aware that some localities are at an altitude of around 1000 m (3000 ft)and field temperatures may exceed 25 degrees celsius.

Who Should Attend

Geologists and geophysicists who wish to gain insights into the nature of a wide range of reservoir analogue sandstone bodies in a basinal context.

Course Content

Fluvial depositional systems

We will undertake a holistic analysis of fluvial systems and their deposits, from hinterland source to depositional sink using two regional scale fluvial systems in the Spanish Pyrenean mountain belt i) Eocene axial, thrust-sheet-top fluvial systems (Tremp-Graus-Ainsa sub-basins); and ii) Oligo-Miocene transverse fluvial systems, feeding into the Ebro foreland basin. The Eocene fluvial system was directed axially along the mountain belt and accumulated more than 1000 m of strata in a thrust sheet top basin. This system was an open system that was coupled down-dip to coastal plain, shoreline and deeper water marine systems. In contrast, the Oligo-Miocene fluvial system was a closed, terminal system directed transversely across the mountain belt. Major fluvial dispersal systems were guided from the hinterland to the Ebro foreland basin. These systems were complemented by more localised fluvial systems produced by actively uplifting structures, particularly at the emergent thrust front. The course will examine the deposits of both of these regional scale fluvial systems in terms of individual sediment bodies, their architecture and connectivity.

Tidally influenced depositional systems

The distribution of tidally influenced depositional systems and sandstone bodies in the Pyrenean basins is strongly controlled by basin configuration. This will be demonstrated via two examples of tidal deposits (Baronia Formation, Ager Basin and Roda Sandstone, Tremp-Graus Basin). The geometry and internal characteristics of these two quite different tidal influenced sandstone bodies will be addressed. Criteria for the interpretation of tidal sandstone facies will be demonstrated and the nature and distribution of permeability barriers and baffles will also be discussed.

Deepwater depositional systems

Deposits of deepwater systems dominate the Ypresian and Lutetian fill of the the Ainsa and Jaca basins and show down-dip changes from slope canyons and channel complexes associated with mass transport complexes, to lobe and basin plain turbidites that include exceptional, megaturbidites. Observations will range through bed-scale depositional element and element stacking scales. Outcrop observations will be complimented by a series of exercises, including synthetic seismic model interpretation and detailed correlations, a view to facies modelling methods and role of heterogeneity, as well as seismic examples from potential analogues.

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Itinerary

Day 0

- Arrival in Barcelona (afternoon) and transfer by bus to Tremp.
- Group dinner in the hotel, overnight - Tremp.

Day 1: Tidal depositional systems

- Presentation: Course safety brief and introduction to the Spanish Pyrenees and basin-scale context for the course.
- Ager Basin, Baronia Formation: tidal facies and sandstone bodies and reservoir potential in a localised, thrust-sheet-top basin.
  Overnight - Tremp

Day 2: Tremp-Graus basin up-dip sector. Alluvial fan, fluvial and coastal plain depositional systems

- Coastal plain deposits at the Montllobat pass: distributary channel, interdistributary bay and crevasse sub-delta facies and sequences in a fluvial-dominated lower delta plain environment.
- Montanana-Castisent fluvial deposits including a regional scale, multi-storey sandstone-dominated sandstone body (Castisent Sandstone), single storey channel bodies, including lateral accretion surfaces and an abandoned meander loop, nature and significance of palaeosols, and discussion of alluvial architecture.
- Sis fluvial palaeovalley. View of structurally controlled, long-lived, up-dip fluvial palaeovalleys represented by regional scale, linear bodies of conglomerate; exploration implication of recognising transfer zone palaeovalleys. Examination of down-dip alluvial fan conglomerates related to the late (Oligocene) phase of the Sis palaeovalley.
  Overnight - Serraduy

Day 3: Tremp-Graus Basin, up-dip sector. The Roda Sandstone, syntectonic, tidal-influenced, fan-delta wedges.

- Roda Sandstone. In depth analysis of tidally influenced fan deltas that pre-date the Sis palaeovalley and are controlled by the same long-lived fault and fold system.
  Overnight - Ainsa

Day 4: Transition from the Tremp-Graus to the Ainsa basin and deepwater depositional systems

- Structure and stratigraphy of the Ainsa basin setting.
- Ainsa Basin: Scale, geometry, stacking patterns and facies characteristics of turbidite channels in the Ainsa sub-basin. Nature and significance of mass transport complexes.
  Overnight - Ainsa

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Day 5: Deepwater depositional systems

- Jaca Basin - lobe and basin plain turbidites, including mega-turbidites that serve as event marker horizons in the deepwater stratigraphy.
  Overnight - Huesca

Day 6: Ebro Basin: a closed, terminal continental basin: basin centre and basin margin alluvial depositional systems

- Basin margin, locally sourced alluvial fan systems.
- Traverse through the emergent thrust front and along the margin of the Ebro Basin (Oligo-Miocene fluvial system). Analysis of locally sourced fluvial systems at an emergent thrust front (Oligo-Miocene fluvial system). Coarse-grained alluvial fans with evidence of syn-sedimentary compressional deformation (growth folds, footwall deformation, 'jacking-up' of depositional dips).
- Basin centre, distantly sourced fluvial megafans; the Huesca fan system, sandstone dominated fluvial channel-fills, alluvial architecture contrast between up-dip and down-dip fan (Oligo-Miocene fluvial system).
  Overnight - Huesca

Day 7

- Depart Huesca and transfer to Barcelona for departure.