N033: Characterisation, Modelling, Simulation and Development Planning in Deepwater Clastic Reservoirs *(Tabernas, Spain)*

Instructor(s): Mark Bentley and Ed Stephens

Format and Duration

Field - 5 Days
Moderate Physical Demand

Summary

This course is led by a production geologist and reservoir engineer involved in deepwater reservoir development, and is presented as a practical reservoir discussion rather than purely a traditional geological field trip. The objective of this field course is to explore the reservoir modelling and petroleum engineering aspects of deepwater clastic reservoirs. The discussion highlights the linkage from depositional processes to geological architecture and flow heterogeneity in development planning. The Tabernas outcrops are very well exposed and offer examples of sand-rich and debris flow-dominated reservoirs, high net:gross fan systems and classic mud-dominated facies. In particular, they give excellent insights into the reservoir heterogeneities occurring within apparently continuous 'sand lobes' and major channels.

Business Impact: This course will be impactful for participants working deepwater developments and producing assets and has a focus on the interconnection between reservoir geoscience and engineering disciplines.

Learning Outcomes

Participants will learn to:

1. Assess the genetic processes that produce slumps, slides, debrites and high/low density turbidites, and explain why the concept of confinement underpins the description of heterogeneity in deepwater clastic systems.
2. Evaluate the extent to which pay is under/over-estimated in mud-rich/sand-rich systems, respectively, and the resulting errors in STOIIP and PI estimation.
3. Organise a detailed sedimentological description into key reservoir elements and build an architectural model using those elements.
4. Assess the basic principle of flow in porous media (Darcy) and describe how flow heterogeneity varies in layered and amalgamated clastic systems.
5. Appraise the contrasting heterogeneities in sand- and mud-rich systems and determine how much detail is required in a reservoir description based on a consideration of fluid type and production mechanism.
6. Evaluate how kv/kh impacts recovery in typical deepwater clastic architectures; optimally locate a well to optimise sweep for a range of architectural cases.
7. Judge length scale variations for a typical deepwater clastic system, and discuss how this would be handled in a reservoir modelling and simulation context.

Training Method

This is a field course, supported by short classroom sessions.

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Physical Demand

The physical demands for this course are MODERATE according to the RPS field course grading system; the course requires good general fitness levels. There will be multiple walks of up to 1 km (0.5 mi) most days. The longest walk of the class is approximately 2 km (1 mi), with an ascent (and descent) of 75 m (245 ft). The field area is in Europe's only desert region and participants should expect high temperatures and an arid working environment. Participants should also be prepared for sudden and heavy rain showers. Transport will be by SUV on paved roads and unpaved tracks.

Who Should Attend

The class is designed for and runs best with a multidisciplinary audience of geologists, geophysicists, petrophysicists and reservoir engineers. Team leaders and managers leading the development and production of deepwater assets would also benefit from attendance.

Course Content

This course covers the following issues:

- Types of submarine fan systems
- Influence of topography on reservoir distribution and quality
- Reservoir heterogeneity
- Reservoir modelling and simulation
- Upscaling from core to simulation scale
- Well selection and placement
- Development planning for submarine fan reservoirs

Approximate Itinerary

Day 0: Arrival in Almeria

Evening course safety brief and introductory lecture followed by group dinner in the hotel.

Day 1: Overview of the Tabernas Basin.

The class begins with overviews, orientation and scale of the Tabernas Basin. Visit to the basin margin to view coarse non-marine and shallow marine clastics which mark the initiation of sedimentation in the basin.

Visits to the deepwater basin-fill succession to see the types of depositional environments in the basin – slumps, slides, debris flows, unconfined and confined turbidites – and a general introduction to deepwater clastic sedimentology and terminology.

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Day 2: Muddy Fan

We visit a series of outcrop sections within a low net:gross submarine fan and typical geometries of those environments - thin-bedded turbidite sheet sands in confined and unconfined settings.

We discuss thresholds of net:gross and the particular issue of thin bed pay. We will use an outcrop-based model example to explore the concept of effective net from an engineering rather than a purely geological perspective.

Day 3: Feeder Systems

We visit a series of outcrop sections to analyse the muddy feeder system and the sandy feeder system. Here we will study the individual architectures of the channelised units and discuss the facies, stacking patterns and evidence for their interpretation as feeder systems.

Thin-skin sliding and soft sedimentary tectonics are also viewed in deeper, more distal sediments.

Day 4: Sandy Fan

We visit a series of outcrop sections within a high net:gross submarine fan; high concentration, amalgamated sands in the lower fan, sheet-like tabular sands in the upper fan and visits to the onlap margin of the body to view the overall geometries.

Here we will conceive an overall sedimentological model for the outcrops and take a reservoir engineering perspective on the observed heterogeneity - does any of it matter? The outcome of this discussion will link through to a well design exercise. Outcrop-based permeability data will be used to support the observations on heterogeneity and to discuss how small scale heterogeneity can be reasonably scaled in to a simulation model.

Day 5: Isolated Channel

We visit a series of outcrop sections to view Tabernas' famous isolated channel and take the opportunity to describe and discuss intra-channel architectures and likely morphologies.

Participants will carry out a modelling exercise on the channel based on their observations. A model developed for the class will be used as a basis for discussion of development planning in submarine fan systems.

Day 6: Depart Almeria