# Sand-rich and Confined Turbidite Systems: Annot, France (G048)

## Tutor(s)

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## Overview

Experience the classic, well-exposed Grès d'Annot turbidite outcrop area in the French Alps, an excellent analogue for deepwater exploration and development targets in structurally active slope and basin settings. This course will provide insights into field development challenges in relatively confined, high-net, submarine fan systems by using the world-class exposures along with static/dynamic models of the outcrops to support discussions. Seismic forward-models of 3-D and 4-D responses to waterfloods in these systems add to the conversation. The setting allows reservoirs to be observed at a range of scales from seismic- and field-scale, to the scale of a core plug, and is intended for a cross-discipline, geoscience and petroleum engineering audience.

## Duration and Logistics

A 7-day field course in the French Alps, comprising field activities and exercises on-site, unless weather doesn't allow. The manual will be provided in paper format, with a digital copy available as a take-away.

## Level and Audience

**Advanced**. The course is designed for integrated teams (geologists, geophysicists and reservoir engineers) evaluating development opportunities for fields in deepwater confined basins. The ideal group would be an asset team, who would be encouraged to bring their own field issues (and data where possible) to discuss live on the analogue.

## Exertion Level

This class requires a **DIFFICULT** exertion level. The Grès d'Annot is quite comfortable in the early summer, with temperatures of 10–25°C (50–80°F) and occasional rain showers. Some field locations require path-based hillwalking involving ascents up to 600m (2000 feet). The longest excursion involves a full-day hike and will be conducted at a leisurely pace.

## Objectives

You will learn to:

1. Assess discrete, structurally controlled sediment transport pathways into bathymetrically complex deepwater basins.
2. Assess the role of relative structural and flow confinement on turbidite reservoir architecture.
3. Characterize internal reservoir architecture in different parts of the system and assess the impact of heterogeneities on fluid flow.
4. Formulate reservoir and simulation modelling requirements, in order to forecast production performance from reservoirs of these types.
5. Determine the level of detail required for reservoir characterization under a range of fluid fills and production mechanisms.

6. Understand how much of the observed heterogeneity would be detectable on seismic, and predict how fluid-sensitive heterogeneities would be visible on 4-D seismic for a field on production.

## Course Content

### Course Details

The Grès d'Annot displays a range of reservoir architectures from high concentration gravity flows. These are often interpreted as 'tanks' of sand in field development scenarios, where much good effort is placed on extracting large-scale sand architectures from seismic. The internal content of sands within these high-net architectures is often assumed to be relatively homogeneous, but this is often not the case. On this course, key heterogeneities that impact fluid flow will be observed, and their significance quantified using on-scale reservoir and simulation models of the outcrops. The extent to which these features can be seen on seismic is evaluated by forward-modelling the outcrops under initial reservoir conditions (3-D seismic forward-models) and after production (4-D seismic forward-models).

Topics covered include:

- Reservoir characterization in high-net, deep marine systems
- Petrophysical expression of reservoir character
- Static modelling techniques for these systems appropriate to a range of fluid fills
- Fluid response to these heterogeneities and dynamic (simulation) modelling requirements
- Seismic expression of field-scale architectures
- Development planning and well placement in these systems

Exercises on-site will include: observation of key heterogeneities; conceptual sketching of a range of architectures; reservoir and simulation model design for those architectures; and interactive discussions on the importance of the observed heterogeneities in development planning (including well placement and production forecasting).

### Day 1: Arrive in Nice

Classroom:

- Course introduction and safety briefing.

*Overnight in Nice.*

## Day 2: Regional Setting

Fieldwork:

- St Antonin and St Benoit – regional scale
    - Regional setting – proximal/distal mini-basins and regional fill-and-spill
    - Large-scale heterogeneity

*Overnight in Annot.*

## Day 3: Gross Reservoir Architecture

Fieldwork:

- Coulomp Valley
    - Gross reservoir architecture
        - Overview of sand distribution – boundaries and contacts
        - Seismic expression – 3-D seismic forward modeling
        - Large scale production performance

*Overnight in Annot.*

## Day 4: Internal Reservoir Architecture

Fieldwork:

- Annot Town
    - Internal reservoir architecture
        - Reservoir heterogeneities
        - Log vs core expression – petrophysical response
        - Fluid sensitivity to heterogeneities
        - Static/dynamic modeling and forecasting
        - Monitoring production – 4-D seismic forward modelling

*Overnight in Annot.*

## Day 5: Contrasting Systems

Fieldwork:

- Col de la Cayolle
    - Contrasting systems
        - Lower net components of sand-rich systems
        - Contrasting reservoir heterogeneities
        - Effective flow properties and sweep efficiency under production
        - How models go bad

*Overnight in Annot.*

## Day 6: Reservoir Margins

Fieldwork:

- Chalufy
    - Reservoir margins
        - Observing on-scale reservoir pinch-outs
        - Seismic resolution of field margins
        - Drilling the edge: well planning influenced by seismic character
        - Observing at outcrop architectures we normally miss

Classroom:

- Course summary and wrap up

*Overnight in Annot.*

## Day 7: Departure

*Return to Nice and travel home.*