
N112: Basin-Scale Analysis of a Confined Turbidite System (Grès d'Annot, SE France)

Instructor(s): David Stanbrook and Gill Apps

Format and Duration

Field - 6 Days

High Physical Demand

Summary

This course analyses the initiation, fill history and links between a suite of structurally confined deepwater sub-basins, with reference to local and regional scale facies and stratigraphic architecture. The course aims to enhance understanding of subsurface deepwater basins that are confined by structures related to salt- or mud-deformation, faults and fault-related topography.

Learning Outcomes

Participants will learn to:

1. Assess discrete, structurally controlled sediment transport pathways into bathymetrically complex deepwater basins.
2. Evaluate the role of basin initiation and closure as external controls on basin fill and remobilization sequences.
3. Assess the role of relative structural and flow confinement on turbidite reservoir and seal facies, reservoir stacking patterns, and stratigraphic architectures.
4. Characterise different reservoir architectures in a series of mini-basins from proximal, shallow marine, through base of slope to mid and distal basin settings.
5. Characterise the range of bed-scale deposits from low density to high-density turbidites, linked turbidite-debrite deposits, and multiple scales of sediment remobilization.
6. Assess the role of active structures, beneath and within the turbidite basin, on slope instability, and predict impact of seismic-scale reservoir heterogeneity (mass transport complexes) on reservoir performance.
7. Validate and combine established models for structurally confined basins and consider the subsurface implications of the different models for linkage between mini-basins.
8. Predict different basin margin onlaps and assess related stratigraphic trap definition and seal integrity risks.

Training Method

A six-day field course, based in the French Alps. 90% of the time will be spent in the field, making active observations singly, and in small teams. A 3D grid of restored structural cross sections are used to provide the structural framework for the linked mini-basins. Photos are used for seismic-scale observations, with logged sections of the outcrop for well-scale, and hands-on study of core-scale bed patterns and facies. Participants will analyse proximal-distal variations within single sub-basins and between mini-basins, and compare a range of mini-basin margins settings. Case studies of subsurface examples of confined mini-basins are used, both in the field and classroom.

Physical Demand

The physical demands for this class are HIGH according to the Nautilus Training Alliance field course grading system. Most Alpine paths traverse obliquely across slopes, but there are exceptions to this rule

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and some paths have steep gradients. There will be walks most days with the longest approximately 15 km (9.15 miles), with an ascent (and descent) of 1000 m (3300 feet) – several of the walks are strenuous and involve being on the mountains for the whole day. The field area is in the French Alps with elevations up to 2500 m (7500 ft); this may lead to unexpected fatigue or shortness of breath in some participants.

Who Should Attend

The course is specifically designed for geologists and geophysicists evaluating exploration provinces or fields in deepwater confined basins, within deepwater fold and thrust belts, rift and early post-rift settings and salt provinces. Experienced reservoir engineers can also derive a deeper knowledge of the geological parameter ranges that underpin simulation models.

Prerequisites and Linking Courses

There are no prerequisites for this course but a basic understanding of clastic sedimentation and stratigraphy, acquired via N155 and N156 (at Basic Application Competence Level) on the Nautilus Training Alliance programme, is assumed. This course is complementary to other deepwater courses on the Nautilus Clastics programme at Skilled Application Competence Level including N009, N028, N315, N107. N252 (Reservoir Geology of Deepwater Systems: Processes, Architecture and Reservoir Quality Analysis (Provence-Alpes-Cote d'Azur, SE France)) visits some outcrops in common with those seen on N112, but in addition visits the Champsaur region. N252 generally focuses more on emplacement process and the depositional expression of deepwater particulate gravity flows. N112 also links very well with N218 (Structural Controls on Deepwater Systems: Growth Structures and Minibasin Fill (Austrian Alps)); this course focusing on the syn-depositional structural influence on deepwater sedimentation.

Course Content

All subsurface geoscientists evaluate confined deepwater basins using a combination of seismic, well, core and existing production data. This course aims to provide structural stratigraphic tools and techniques for analysing these basins by using outcrop examples of an analogous suite of linked deepwater minibasins. Observations, discussion and prediction in the field range from large (seismic) scale to small (core) scale. At all times, participants will make outcrop observations in the context of subsurface data, in plays from deepwater fold and thrust belts, rift and early post-rift settings and salt provinces.

The Grès d'Annot includes a range of bed-scale deposits: low and high concentration turbidites, debris flows as well as slumps and slides. Deepwater reservoir architectural elements discussed will include: thin- and thick-bedded turbidite lobes, turbidite channels, seismic-scale mass transport units, and reservoir bodies in basin margin onlap settings.

As the course progresses, participants will gain an appreciation of the different reservoir architecture within, and between individual sub-basins, and be in a position to predict the factors controlling these differences. This will lead to an improved understanding of the distinctions between partially confined and ponded basins, and the effects of confinement on bed-scale deposits, architecture, reservoir stacking patterns and stratigraphic basin-fill sequences. At every stage in this course, the implications for reservoir

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presence and deliverability, seal presence, and stratigraphic trap integrity are predicted and considered within the constraints of data available to subsurface geoscientists in different parts of the value chain.

Day 0

Arrival in Nice and transfer to hotel.

Evening course safety brief and introductory talk followed by group dinner.

Day 1

Analysis of the up-dip, basin margin feeder system to the Gres d'Annot basin and its potential impact on sediment delivery to the deepwater system. Location of the principal deepwater sediment transport pathways of the Gres d'Annot and controls on their position.

Day 2

Initiation of the Grès d'Annot basin: brief examination of deformed Cretaceous limestones and base Tertiary unconformity, and the deepening sequence of Calcaire Nummulitique and Marnes Bleues culminating in the deposition of Grès d'Annot turbidites.

Analysis of key localities that define the nature of the proximal Annot sub-basin and its fill succession. Seismic-scale examination of high net:gross architectures followed by closer inspection of onlap facies characteristics. Initial discussion of alternative interpretations of the Annot sub-basin as either a through-going channel complex, or a confined or ponded basin.

Day 3

Sedimentology and depositional architectures of a high net:gross sheet-like system and channels.

Examination of late stage extensional faults in Grès d'Annot. Discussion of sheeted seismic facies and its significance in subsurface deepwater systems.

Col de la Cayolle: Termination of the basin phase with Grès d'Annot turbidite deposition halted and eroded into by the Schiste-a-Bloc – a thrust propagated, seismic scale mass transport complex with large scale debris flows, olistoliths on decametre to kilometre scale.

Day 4

Annot: Examination of major syn-depositional fault within the proximal Annot sub-basin. Close inspection of high-density turbidity current deposits within a strongly confined conduit. Onlap surfaces close to the potential spill point between the proximal Annot sub-basin and the medial Grand Coyer sub-basin.

Generic discussion of spill point characteristics in subsurface confined basins.

Day 5

Grand Coyer: Analysis of three-dimensional sandstone bodies and stacking pattern characteristics of the turbidite system in the medial Grand Coyer sub-basin; insights into different scales of heterogeneity within a sand-rich turbidite system. Observations on lateral facies variations from sub-basin margin to sub-basin axis, including the effects of gravitational growth faulting.

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Day 6

Montagne de Chalufy: Anatomy of onlap surfaces at the margins of a distal sub-basin, axial to lateral changes in depositional elements and sand-bodies, and precise nature of sand-body terminations onto the onlap surface. Discussion of the seismic expression of onlap surfaces and onlap plays in sub-surface confined basins. Deepwater channel architecture and filling styles.

Discussion on the links between the Grès d'Annot proximal, medial and distal sub-basins and relation to 'fill and spill' basins.

Day 7

Return to Nice and departure.