N218: Structural Controls on Deepwater Systems: Growth Structures and Minibasin Fill *(Austrian Alps)*

Instructor(s): Douglas Paton

Format and Duration

Field - 7 Days
High Physical Demand

Summary

This course will familiarise participants with the principles of structural development of growth folds and controls on deepwater systems. The course is primarily field-based, integrated with theory and practical sessions interpreting analogous subsurface data.

Learning Outcomes

Participants will learn to:

1. Characterise the large scale tectonic elements of the northern Calcareous Alps and their evolution during the Alpine orogeny.
2. Assess the role of thrust tectonics on the development of the Gosau basin during early Alpine deformation.
3. Evaluate the mechanisms of folding and faulting, fault/fold propagation and the controls on accommodation in the developing Gosau piggy-back basin.
4. Appraise fold limb evolution models (limb rotation vs. kink-band migration) and their influence on growth stratal patterns.
5. Evaluate the development of basin-fill sequences within a strongly structurally- controlled basin setting.
6. Predict stratigraphic stacking patterns within turbidite and mass transport complexes on the limb of a growing fold.
7. Validate models of growth fold evolution and contrast these with a range of field-based examples.
8. Assess seismic data to interpret growth fold structures and their associated stratigraphic packages.
9. Integrate knowledge gained on the geometry, variability and scale of growth fold systems with subsurface data.

Training Method

A seven-day field course comprising a mixture of field excursions, lectures and practical sessions. The proportion of field and classroom time is approximately 90/10.

Physical Demand

The physical demands for the course are HIGH according to the Nautilus Training Alliance field course grading system. Many of the outcrops are at high altitude (2000-2500 m) and participants must be in good physical condition and capable of hiking steep paths, in an alpine environment, on multiple days. Participants should be comfortable with reasonable exposure and heights as outcrops are accessed using recognized and maintained mountain paths which in places can be moderately narrow and steep. In addition, the group will use chairlifts to access parts of the field area.

Who Should Attend

Exploration and development geologists and geophysicists concerned with the exploration and exploitation of structurally-controlled deepwater basins. Reservoir engineers seeking more information

about stratigraphic architectures of deepwater reservoirs.

Course Content

The Cretaceous Gosau deepwater basin, western Austria, provides an exceptional example of syn-depositional structural influence on a deepwater sedimentary basin. In particular, the Muttekopf Gosau minibasin shows significant variations in proximal-distal and axis-margin basin fill that can be observed and related to changes in the basin's structural configuration. This primarily field-based course will examine these variations and the controlling structural configuration at a variety of scales from that comparable to minibasins (~10 km) through seismic scale (10s-100s m) to reservoir scale (m) thereby providing an excellent analogue for many structurally-controlled deepwater exploration basins.

Itinerary

Day 1: Overview of Regional Geology of the Northern Calcareous Alps and Muttekopf Minibasin setting

An introduction to the regional Alpine setting of the Gosau deepwater basin in the Alpine orogeny. Development of frontal fold and thrust belts in the Alpine foreland. Evolution of deepwater depositional systems in the Alpine foreland. Introduction to the Muttekopf Minibasin.

Day 2: Proximal basin stratigraphy: Overview of the Western Muttekopf Gosau Minibasin

Introduction to the seismic-scale of the minibasin and the gross stratigraphy that can be correlated across the basin. The remainder of the day will focus on the proximal portion of the basin:

- Structural configuration and proximal stratigraphy of minibasin
- Stratigraphic nature of the units here include amalgamated channels with very little fines
- What were the structural controls in this location during deposition?
- Examination of field logs and drawing on sequence boundaries, use of photo-panel of outcrop and drawing on geometry of package
- What are the implications for reservoir quality and connectivity?

Day 3: Seismic scale growth strata and geometry: Schlenkerkar Section Overview

Consider the seismic scale variation of the Muttekopf Gosau minibasin from proximal to a central location:

- Use panoramic overviews coupled to three stratigraphic logs and photopanels
- Analyze intra-basin deformation, including correlation between sections, nature of the southern boundary, onlap onto northern margin, development of mass transport systems and potential reservoir facies in this structurally-controlled deepwater system
- Compare and contrast mass-transport deposits derived from deformed basin margin with those that are correlatable across the basin

Day 4: Reservoir scale growth strata and geometry: Schlenkerkar Section

Focus on the seismic to reservoir scale of the Schlenkerkar section, which is in the central part of the Muttekopf minibasin:

- Examine small scale structures developed in the hinge area of the major growth fold
- Slump folds vs. later folding and thrusting?
- Tie-in of stratigraphic section from log into view of section. Examine finely-bedded turbidite packages and discuss details of turbidite sedimentology in this part of the minibasin fill
- Consider stratigraphic variations within the packages and discuss how it fits into the overall minibasin fill history and structural evolution. This is the location that demonstrates greatest accommodation space in the basin

Day 5: Seismic Interpretation of Analagous Deepwater Systems

Morning transfer to eastern part of Muttekopf Gosau minibasin. Afternoon classroom seismic exercises and discussion of structurally-controlled deepwater systems in seminar room at hotel.

Day 6: Distal stratigraphy, structural complexity and basin compartmentalisation: overview of Eastern Muttekopf Gosau Minibasin

Overview of the fault bound southern margin of the eastern minibasin:

- Note the tight fold geometry of the southern minibasin and discuss structural thinning of fold limbs during folding
- Discuss variation in fracturing on each limb and lithological variation in deformation mechanism
- Overview of minibasin filling sequences with discussion on the origin of the olistoliths within the sequence

Day 7: Integration from reservoir to seismic to mini-basin scales: Distal eastern Muttekopf Gosau Minibasin

Overview of panorama of the distal portion of the Eastern Muttekopf Gosau minibasin. Aim of this view is to discuss the significant variation in basin width in this more distal setting, the gross structural configuration and the associated development of the basin fill:

- View outcrops of Lower Gosau subgroup. How does our structural model account for the rapid increase in water depth and accommodation?
- Outline proximal to distal thickness variation in minibasin and discuss structural controls on sediment ponding
- Overview of high resolution deformation from above the Muttekopf Hut. There is a spectrum of deformation from soft-sediment through to post-lithification deformation
- Course wrap up discussion at Muttekopf hut

Note on logistics:

The accommodation in Innsbruck and Imst will be in 3/4 * hotels with all modern facilities. The remainder

of the accommodation is at traditional mountain hotels in remote locations that can only be accessed by walking with luggage transferred by cargo lift. Therefore, although perfectly adequate, the accommodation is relatively basic. This includes the necessity to share bunk-rooms (2 or 4 people), limited shower facilities and traditional Austrian food from a set menu that has little choice (limited vegetarian options). There is no telephone, mobile telephone network coverage, broadband or internet access while staying in mountain huts. The huts do have teaching rooms and the instructors will be prepared for classroom teaching with seismic exercises if the weather is particularly bad.