

N115: High Resolution Sequence Stratigraphy: Application to Deltaic Systems and Reservoirs (*County Clare, Ireland*)

Format and Duration
Field - 6 Days
Low Physical Demand

Instructor(s): Andy Pulham and Sarah Davies

Summary

Deltaic depositional systems are excellent settings for the examination and application of sequence stratigraphic concepts and outcomes. This course provides a comprehensive review of deltaic processes and their resultant deposits, focusing particularly on the application of high-resolution sequence stratigraphy methods in a high frequency, high amplitude glacio-eustatic context.

Learning Outcomes

Participants will learn to:

1. Characterise deltaic key sub-environments and their associated sandstone bodies, including delta front, delta plain and associated fluvial settings.
2. Assess the sedimentology and stratigraphic architecture of deltaic settings through the recognition of key stratigraphic surfaces; specifically sequence boundaries and a spectrum of transgressive flooding surfaces that commences with maximum and initial flooding surfaces.
3. Evaluate parasequences and their stacking patterns in a deltaic context.
4. Develop correlative frameworks in deltaic deposits that utilise key stratigraphic surfaces, rather than lithostratigraphy.
5. Evaluate lowstand deposits including incised valleys, their associated interfluvial surfaces and prograding lowstand wedges composed of shelf-edge deltaic deposits.
6. Characterise deposits of the transgressive and highstand systems tracts.
7. Assess the relative importance of different systems tracts to the overall stratigraphy in a given case study.
8. Evaluate the nature and extent of synsedimentary deformation in deltaic systems, including the key processes, deformational types and implications for reservoir characterisation.

Training Method

A six-day field course based in the Upper Carboniferous Clare Basin. The proportion of field time to classroom time is approximately 80:20. Participants will be trained in the sedimentology and sequence stratigraphy of deltaic deposits via integrated lectures, exercises, field observations and discussion.

Physical Demand

The physical demands for this class are LOW according to the Nautilus Training Alliance field course grading system. The sections are almost entirely coastal foreshore and cliff sections on the Atlantic side of the Clare Peninsula. Walking distances are short (generally around 1.25 miles but up to 3 miles in length, over flat coastal paths and pasture) and ascents minimal. If conditions allow, the group can undertake a 5 km (3 miles) walk along the top of the Cliffs of Moher. This involves the group negotiating a narrow path with shear, 200 m (500 ft) drops to the ocean - this walk is unsuitable for vertigo sufferers.

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Who Should Attend

Geologists and geophysicists concerned with analysing data from up-dip, basin margin locations in terms of reservoir presence and characterisation. More specifically, those wishing to gain a pragmatic, practical guide to the use of sequence stratigraphic methods in analysing, correlating and interpreting deltaic systems in the subsurface. Also those concerned with the prediction of deepwater deposits fed directly via up-dip deltaic settings.

Prerequisites and Linking Courses

It is assumed that participants will have a knowledge of the fundamental process and terminology of sedimentology and sequence stratigraphy before attending this class. This can be gained on Basic Application Competence Level courses N155 (Introduction to Clastic Depositional Systems: a Petroleum Perspective) and N156 (Clastic Depositional Systems in a Basinal Framework: Exploration and Reservoir Implications, Pyrenees, Spain). Regionally geoscientists could expand on lessons learnt on N009 (Sedimentology, Stratigraphy and Reservoir Geology of Deepwater Clastic Systems, County Clare, Ireland) and, more broadly, on other sequence stratigraphic field courses based in the USA including N011, N035, N042, N117.

Course Content

Their location at the margin of basins results in records of relative sealevel change that can provide predictive models for the deltas themselves and also for the down-dip, deepwater systems they commonly supply. Understanding the nature of deltaic sedimentation is therefore critical to many aspects of clastic basin fill stratigraphy and petroleum exploration. The Upper Carboniferous Clare Basin contains an upward shallowing siliciclastic succession capped by 900 m of fluvio-deltaic deposits that outcrop along 60 km of the western Ireland coast. The Clare deltas are fluvial-dominated with significant wave-influence and were deposited in a near tideless intra-cratonic basin. Both deepwater and shallow-water deltas are represented along with thick, regional-scale sandstone bodies. The ice-house world of the Upper Carboniferous resulted in high magnitude and high frequency fluctuations in relative sealevel. These global conditions promote a sequence stratigraphic record in the deltas that allows confident recognition of key surfaces and identification and mapping of depositional systems tracts.

The Clare deltas exhibit a wide variety of instability related structures, including growth-faults, mud-diapirs and slumps and slides. These synsedimentary deformation features are a common constituent of sub-surface deltaic systems (e.g. Gulf of Mexico, Nigeria, SE Asia, North Sea) and are rarely exposed as well as in the Clare Basin.

The quality and orientation of the Clare outcrops compliments other GTA deltaic courses and provides the following contrasting sedimentological and stratigraphic opportunities:

- Large, continental-scale sediment supply and fluvial-dominated systems
- Mixture of shelf-margin deltas and shelf deltas
- High subsidence rates in a passive, post-rift tectonic setting

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- Strong glacio-eustatic control on sequence stratigraphic signatures
- Strike orientated outcrops that deliver an extensive range of key surface expressions
- Linkage to down-dip deepwater settings

The course will examine the following aspects of deltaic sedimentation and stratigraphy:

- Lowstand wedges, including shelf-edge deltas
- Incised valley fills and related interfluvial palaeosols
- Transgressive systems tracts, including shelf deltas
- Hierarchy of flooding surfaces, including regional condensed sections
- Synsedimentary deformational features; their variety and stratigraphic significance
- Gamma ray spectrometry of sequence stratigraphic key surfaces and sediment bodies
- Deltaic sedimentation within a high resolution biostratigraphic framework

Day 0

Arrival and transfer to Kilkee.

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

Day 1: Lectures and Field

Introduction to deltaic depositional systems; and basin margin sequence stratigraphy; Introduction to the regional context and the Upper Carboniferous deltaic systems of the Clare Basin.

Day 2: Field

Lowstand System Tracts: prograding wedges and incised valley sedimentation and stratigraphy.

Day 3: Field

Transgressive System Tracts: variety of flooding surfaces, condensed section sedimentation and variability in valley fills.

Day 4: Lectures and Field

Synsedimentary deformation in deltaic systems; processes, structures and implications to stratigraphic analysis and reservoir characterisation. Outcrop examples; growth-faults, slumps, slides, gullies and diapirs.

Day 5: Exercises and Field

Application of sequence stratigraphic concepts to subsurface examples; systems tract recognition and predictive implications.

Testing of methods at outcrop.

Day 6: Field

Sequence boundaries and interfluvial - sedimentology, palaeosols and subsurface recognition. Low accommodation settings at the basin margin; comparison with deepwater deltas and down-dip changes in incised valley fills.

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Review and summary discussion of key learnings.

Day 7

Transfer from Kilkee and departure.