Modern and Ancient Tide- and Wave-influenced Depositional Systems: Subsurface Uncertainties in Shallow Marine Reservoirs, SE England, UK (G070)

Tutor(s)

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Overview

Tide- and wave-influenced marginal marine hydrocarbon reservoirs offer a range of subsurface interpretation and development challenges. This course will use both modern and ancient systems to analyze the architecture, internal characteristics, distribution and reservoir quality of a variety of sand-dominated deposits. Modern deposits of the North Norfolk coastline will be used to explore the range of depositional processes operating and the resultant spatial distribution and internal attributes of potential reservoir units. These will be compared with Lower Cretaceous outcrops preserving a range of tidal-influenced and marine embayment deposits. Focus will be placed on the key development challenges in these marginal marine clastic systems.

Duration and Logistics

A 5-day field course comprising a mix of fieldwork, classroom lectures and practical sessions. Classroom learning and field observations will be supported and reinforced by exercise work. The course will be based in Hunstanton with easy access to the coastal field area. Transport will be by coach.

Level and Audience

Intermediate. The course is intended for geologists and reservoir engineers with a knowledge of petroleum geoscience who are working on marginal marine reservoir systems, particularly those preserving evidence of tidal influence.

Exertion Level

This field course requires an **EASY** exertion level. The first field day is in a quarry at Leighton Buzzard and involves a walk of about 2km (1.25 miles) to the main quarry face. The remaining field locations on the Norfolk coast are accessed by walks of less than 3.5km (2 miles) along flat sandy beaches and tidal channels that may be muddy and slippery in parts.

Objectives

You will learn to:

1. Interpret the depositional processes and environments that occur in fluvial-, tide- and wave-influenced clastic coastal depositional systems and relate these to the recognition of their ancient equivalents.
2. Relate individual modern environmental systems to the larger regional-scale, including modern and ancient marine embayment and coastal barrier systems.

3. Consider the range of geological controls on the reservoir architecture of clastic coastal deposits and relate this understanding to prediction of reservoir sand presence, geometry and rock properties.
4. Analyze shallow marine sands in outcrop, with particular focus on internal heterogeneity, including potential permeability barriers and baffles.
5. Assess the broader scale outcrop setting, in terms of the basinal depositional framework and use this understanding to inform prediction of reservoir distribution.
6. Place clastic coastal depositional systems into their sequence stratigraphic significance, including addressing reservoir occurrence in transgressive and regressive settings.
7. Use the modern and ancient examples discussed in the classroom and observed in the field to consider implications for exploration and development, particularly with regards to the subsurface reservoirs of the North Sea.

Course Content

Course Details

Shallow marine systems are influenced by waves, tides or rivers. The course will examine shoreline and shelf systems from basic sedimentology through to specific petroleum issues. Data from modern depositional settings, surface outcrop exposures and subsurface data will be combined to develop an in-depth introduction to the petroleum potential of these depositional systems.

Tidal reservoirs can include good-quality sandstones, but often preserve a significant component of heterolithic (mud / sand) facies at a range of scales. These present challenges predominantly with respect to reservoir modelling and the associated permeability of heterolithic facies / bud-sand alternations in relation to fluid content. Exploration in frontier or mature provinces can target potential sites for tidal sand bodies by integrating an understanding of the regional tidal regime with locations where sand supply enters the basin margin. Working within a depositional and stratigraphic framework to define the context of tidal deposits and the scale and orientation of the potential reservoir units is a strategy that will be explored in this course.

The course will be framed around three themes:

Lower Cretaceous tide-dominated estuarine and marine embayment facies (Lower Greensand Group) at Leighton Buzzard

The Lower Cretaceous Woburn Sands is interpreted as a tide-dominated sandy system deposited in a transgressive incised-valley or tidal seaway. Quarries around Leighton Buzzard preserve a variety of tide-dominated faces and, more recently, have been interpreted as representing a change from a narrow estuary setting to a broad marine embayment. NW Europe experienced sea-level rise during the Lower Cretaceous, resulting in widening of the ocean connection and, when combined with local paleogeographic influences, led to tidal dominance in southern England. The course will visit one of the quarries to view the outcrop and enable comparison with the modern depositional system.

Modern sedimentology of a wave-dominated, prograding and accreting coastal barrier system of the North Norfolk coast

The modern depositional system of the North Norfolk coast is characterized by a westward prograding and accreting barrier system. The low-gradient shore profile forms a classic barrier coastline with barrier islands and intertidal sandflats backed by dunes, salt marshes and inter-tidal channels. Locally ebb tidal deltas form at the mouth of larger tidal channels. Onshore wave action from the northeast and longshore wave action supply sediment from the east. The course will explore this system with field visits to explore modern sedimentology.

Modern sedimentology of a tide-dominated marine embayment (The Wash)

The tide-dominated Holocene Wash embayment is a macrotidal, coastal embayment facing out into the North Sea. It evolved in the early Holocene, during transgression, from an estuarine valley into a broad, tide-dominated marine embayment. It receives little sediment input from the local rivers and is dominated by local marine sediment supply sources from waves and tides. A variety of depositional bodies and facies preserved in The Wash will be discussed during the course.

Day 1: Arrive in London

Morning arrival in London.

Classroom:

- Course introduction including aims and objectives
- Clastic coastal-shelf depositional systems lecture and
- Safety briefing

Overnight in London.

Day 2: Ancient tidal deposits

Fieldwork:

- Munday’s Hill Quarry, Lower Cretaceous Greensand Group

Classroom:

- Geological controls on clastic coastal-shelf depositional systems
- Internal / auto-cyclic factors (processes, environments)
- External / allocyclic factors (RSL, tectonics, eustasy, hinterland)
- Concepts and applications to E&P

Overnight in Hunstanton.

Day 3: Modern tidal deposits

Classroom:

- Reservoir characterization and 3-D reservoir geological models
- Modern and ancient (outcrop) analogues;
- Static vs dynamic models;
- Heterogeneity type, scale and significance

Fieldwork:

- Wells-next-the-Sea; channel and beach – observation of sand bodies, small-scale sedimentary structures and geometries

Overnight in Hunstanton.

Day 4: Salt Marsh

Classroom:

- Holocene deposystems of the North Sea (Humber, Wash, Thames, Meuse, Rhine Estuary, Rhine Delta, Elbe/Weisser)
- Large-scale context of the Wash / North Norfolk area

Fieldwork:

- Stiffkey – walk across salt marsh to observe sedimentary changes

Overnight in Hunstanton.

Day 5: Modern shoreface

Classroom:

- Synthesis of learnings

Fieldwork:

- Brancaster: shoreface, ‘old mud’ – evidence of pre-existing coastal plain and tidal channel, coastal plain / salt marsh interface

Return to London for travel home.