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## N499: Shallow Marine Reservoir Analogues and their Application to the Jurassic of the North Sea (*Isle of Skye and Raasay, UK*)

Instructor(s): Ronald Steel and Uisdean Nicholson

### Format and Duration

Field - 5 Days

Field - 5 Days

Moderate Physical

Demand

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## Summary

The objective of this field course is to examine the Jurassic shallow marine reservoirs of the Hebridean Basins. Discussions will highlight the linkage between active tectonics and depositional processes and will emphasise the importance of a sequence stratigraphic perspective in order to correlate. Outcrop information is integrated with well data across a range of scales to demonstrate the subsurface workflows required to populate interwell areas of reservoir models. Reservoir architecture and heterogeneity will be addressed in the context of fluid flow, development planning and reservoir management and surveillance.

This trip is relevant for shoreface reservoirs such as the Fulmar and the Ula Formations of the Central North Sea, but also the Brent Group (Broom, Rannoch, Etive and Tarbert Formations) of the Northern North Sea. The scale of the outcrops offer a regional scale of investigation that will be useful for explorationists but the outcrops also provide an excellent opportunity to discuss shallow marine reservoir characterisation and performance.

## Learning Outcomes

Participants will learn to:

1. Describe shallow marine facies in a consistent manner
2. Assess the genetic processes which produce various sedimentary structures, bioturbation, diagenetic features etc.
3. Explain why the structural framework and degree of tectonic activity at time of deposition underpins the reservoir stacking patterns and heterogeneity in shallow marine systems.
4. Evaluate the extent to which the palaeocoast can be correctly oriented, offshore and onshore (proximal to distal) assessed and net to gross predicted in such systems.
5. Provide a frame for a reservoir description including the key architectural elements that will likely govern reservoir behaviour.
6. Evaluate how reservoir quality impacts recovery in typical shallow marine reservoirs. Comparison of bottom water vs. edge water sweep and linkage between structural framework and depositional processes in order to optimally locate infill wells to optimise sweep for a range of architectural cases.
7. Describe how flow units could be defined and may operate during production. Discuss the way in which heterogeneities may impact production, perforation strategies and or injection / sweep depending on fluid type and drive mechanism.
8. Discuss how tidal channels would be / should be handled in a reservoir modelling and simulation context.

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### Training Method

A five-day field course which comprises fieldwork and associated exercises, supported by evening presentations and discussions. The proportion of field to classroom time is approximately 70/30. The fieldwork is supplemented by reservoir analogues from key North Sea fields.

### Physical Demand

The physical demands for this class are MODERATE according to the Nautilus Training Alliance field course grading system. The longest walk on the class is approximately 3 km (2 miles) into the field area (Screapadal). One outcrop (Berreraig Bay) requires participants to walk down a steep path to the beach with a descent (and later ascent) of 180 m (550 feet). There will be walks of around 1 km (0.5 miles) most days. The field area is in NW Scotland and participants should expect a range of temperatures (6 - 12 deg C) and prepare for a wet and windy working environment. Transport will be by coach on paved roads.

### Who Should Attend

Geoscientists who have worked with clastic depositional systems and want to further improve their understanding, interpretation skills and predictive ability of reservoir properties encountered within shallow marine depositional environments. Petrophysicists, reservoir engineers or production engineers who wish to gain a better understanding of the subsurface and view at first hand the anatomy of a classic reservoir type.

The Hebridean Basins are the perfect location for multi-disciplinary teams to come together to collaborate and interact with highly suitable analogues as a backdrop for targeted discussions that will add value to any asset.

### Prerequisites and Linking Courses

Participants must have some subsurface experience with clastic reservoirs in order to derive maximum benefit from this course. There are no prerequisites for this course but a basic understanding of clastic sedimentation and stratigraphy is assumed.

This course is complementary to other courses in the Nautilus Training Alliance Clastics programme at Skilled Application Competence Level including N096 (Recent Depositional and Stratigraphic Analogues for Fluvial and Shallow Marine Reservoirs - South Carolina, USA). N520 (Coastal, Deltaic and Shallow Marine Clastic Reservoir Characterisation) and W019 (North Sea Reservoir Series - Triassic Reservoirs Overview).

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### Course Content

Shallow marine clastic depositional processes are economically critical to understand as vast quantities of the North Sea's hydrocarbons are reservoired in Fulmar, Ula and Brent shoreface type reservoirs.

During the course, participants will learn to describe and characterise shallow marine clastic deposits based upon a sound understanding of sedimentary processes. Attendees will acquire the necessary skills, methods and approaches needed to relate facies and architectural variations to both local and basinal contexts.

The development of these reservoir types in actively subsiding half grabens leads to particular geometries and architectures that vary both spatially and temporally at a range of scales. This course provides the tools to allow participants to predict net to gross. They will also gain experience in assessing the appropriateness of analogues for use in the subsurface and will begin to consider how to frame the building of a reservoir model.

In addition to the abundance of reservoir analogues, the Skye and Raasay field areas also include examples of source, seal and exhumed traps in a region perfectly suited to review all the elements of the petroleum system.

### Itinerary

#### Day 1:

Depart from Aberdeen / Inverness

General geology of Scotland during journey

Course introduction and safety briefing

The geology of Skye

Berreraig Sandstone Formation Overview

#### Day 2: Field and Lecture

Travel to Berreraig Bay to see the type site of the Berreraig Sandstone Formation

Introductory lecture on shallow marine processes

Exercise: Produce a sequence stratigraphic summary of the Berreraig Bay Outcrop and Upper Glen I well

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Review the specific field aims for Day 2: make a prediction of the proximal to distal variation on the dip slope of an active half graben and discuss reservoir prediction results including Upper Glen I well

**Day 3: Field and Lecture**

Take ferry to Raasay and describe tilted fault block structures at oil field scale

Travel to Screapadal: Examination of proximal stacking patterns including tidal channels

Discussion of the importance of channelised sedimentary architectures in production

Summary lecture:

Review of key insights from the field and review half-graben correlations

Review specific field aims for Day 3: a prediction of shallow marine processes and products in tidal straits

**Day 4: Field and Lecture**

Drive to Glasnakille on the Strathaird Peninsula

Bathymetric confinement effects due to narrow half graben. Rates of subsidence and sedimentation. Depositional styles and signatures in tidal straits.

Continue on to see the Elgol Sandstone Formation

Summary lecture:

Review the reservoir potential of deposits in a tidal strait discussing compartmentalisation (both stratigraphic and igneous dykes) and a tank of sand versus homogeneously heterogeneous descriptions?

Review of key insights from the field trip as a whole, including a palaeogeographic summary and synthesise key take home messages for participants.

**Day 5:**

Travel back to Aberdeen / Inverness

Stopping to see modern examples of fluvio-deltaic systems on the way.