N963: Fluid Flow Mechanisms: Inferring Fluid Movement from Outcrop Data and Implications for Reservoir Development

Instructor(s): Pete Smith and Lance Morrissey

3 Days	Competence Level: Skilled
Field Course	
Classroom Elements	
LOW	Low Physical Demand
3D Outcrop Imagery	

Summary

The course will firstly examine a variety of sedimentary deposits, characteristic of different reservoir rocks, and then explore the processes that control fluid flow through these rocks and the implications for the development of a field. This is a unique course that should appeal to Geoscientists and Engineers alike, the former will gain a deeper understanding of interpreting outcrops in the context of their impact on fluid flow; whilst the latter will be able to develop a detailed impression of the variability and heterogeneity of geological settings.

Learning Outcomes

Participants will learn to:

1. Appraise the influence of geological features, such as boundaries and grain-size changes, to understand and map the displacement and sweep of fluids in the reservoir.
2. Characterise the dimensionless parameters that quantify the competition of forces controlling flow.
3. Construct simplified models that provide context for concepts such as relative permeability and up-scaling.
4. Assess the influence of geometry on the permeability, anisotropy and capillary trapping within individual layers.
5. Evaluate the influence of layering, and permeability contrasts between layers that impact production profiles.
6. Assess the challenges of up-scaling, to describe the macroscopic structure of the formation on a field scale.
7. Predict the impact of geological heterogeneities upon reservoir modeling, reservoir uncertainty and development planning.

Duration and Training Method

This is a 3 day course run either as:

(a) A field course with visits to outcrops, supplemented by classroom sessions
(b) A classroom course using 3D digital outcrop imagery to explore the geology

Participants would work on a range of data gathering exercises both in the field of using 3D digital outcrop data, and these will be worked-up as part of the classroom sessions.

Physical Demand

The physical demands for this class are LOW according to the Nautilus Training Alliance field course grading system. Access to the coastal outcrops is easy and predominantly involves following cliff top paths

N963: Fluid Flow Mechanisms: Inferring Fluid Movement from Outcrop Data and Implications for Reservoir Development

Instructor(s): Pete Smith and Lance Morrissey

3 Days	Competence Level: Skilled
Field Course	
Classroom Elements	
LOW	Low Physical Demand
3D Outcrop Imagery	

or moving over flat, scrubby-open pasture. The longest walk on the field course is approximately 3 km with most under 0.5 km. Many field localities require participants to walk on wave-cut, rocky platforms and beaches.

Who Should Attend

This course is aimed at Reservoir Engineers who wish to develop a better understanding of the variability and heterogeneity of geological settings, with respect to fluid flow mechanism and consequent impact upon field developments. However, Geoscientists may also gain an improved focus on what are the important geological variabilities in relation to fluid flow.

Prerequisites and Linking Courses

The basic theory of clastic depositional systems will be covered as part of this course. Participants should, at a minimum, be familiar with the basic principles of reservoir engineering. The course links well with a variety of other courses on the Nautilus Engineering Programme including those focusing on well performance (e.g. N940: Modern Completion and Production Enhancement Techniques) and geomechanics (e.g. N445: The Subsurface Applications of Geomechanics).

Course Content

Geological visits/3D Digital Outcrop Elements

The field aspects of the course study will be based in County Clare, Ireland, where, there are outcrops representing a range of depositional environments including deltaic and deep marine. The field visits each day of the course, will provide exposure to the detailed heterogeneities of the different geological strata.

A similar schedule will be adopted if the course uses 3D digital outcrop imagery; the outcrops are simply substituted with the corresponding 3D outcrop model.

The focus on both approaches will be consideration of how the geological heterogeneities may influence and control the flow, including the importance of baffles and barriers.

Modelling Elements

In conjunction with the geological elements the numerical modeling approaches will be considered using seminars and tutorials to describe:
(i) description of the reservoir, including the importance of mass balance, the sensitivity to location of boundaries and estimation of the fraction of the pore space which may be accessible to displacement and sweep of hydrocarbons
(ii) development of dimensionless parameters to quantify the competition between the processes

N963: Fluid Flow Mechanisms: Inferring Fluid Movement from Outcrop Data and Implications for Reservoir Development

Instructor(s): Pete Smith and Lance Morrissey

3 Days	Competence Level: Skilled
Field Course	
Classroom Elements	
LOW	Low Physical Demand
3D Outcrop Imagery	

controlling the flow, both based on the geological heterogeneity and the fluid properties and forces at play
(iii) simplified models to quantify and illustrate the impact of the key controls on displacement and sweep, to provide context for use of concepts such as relative permeability and up-scaling
(i) of the boundaries and the parameterisation of material properties within each layer

Itinerary

Day 0
Fly to Shannon and travel to Kilkee
Evening course introduction and saftey brief
Overnight Kilkee

Day 1
AM - Deep marine deposits – channels (Kilbaha Bay) and sheets (Loop Head)
PM - Discussion of porous media, permeability and importance of layering on recovery
Overnight Kilkee

Day 2
AM – Deltaic– distributary channel (Tullig Point), Incised valley with fluvial fill (Trusklieve),
PM- Discussion of capillarity, residual saturation, wetting, and impact on recovery; faults and fractures
Overnight Kilkee

Day 3
AM – Mouth bar and growth fault (Kilkee), Fluvial and Aeolian (using 3D digital outcrop imagery)
PM - Discussion of how uncertainty can be included in Modelling. Case studies and review of impacts of different aspects of geological complexity in developing and exploring models for reservoir prediction and interpretation of production
Overnight Kilkee

Day 4
Transfer to Shannon and flight home