
N386: Reservoir Model Design (*Pembrokeshire, UK*)

Instructor(s): Mark Bentley and Philip Ringrose / Ed Stephens

Format and Duration

Field - 5 Days

Low Physical Demand

Summary

The course offers a software-independent view on the process of reservoir model design and simulation model-building. It tackles the underlying reasons why some models disappoint and offers solutions that support the more efficient construction of fit-for-purpose models.

The thread through the course is a model design for the notional 'Pembroke Field' – a synthetic field constructed from reservoir analogue outcrops in South Pembrokeshire. The Pembroke Field contains three contrasting reservoir types: continental clastics, shallow marine deltaics and naturally fractured carbonates, in both structurally deformed and undeformed settings. Data from producing oil and gas fields has been scaled to the synthetic models to create a realistic hydrocarbon field accumulation, ready for development.

Business Impact: Considerable time is dedicated to reservoir modelling and simulation exercises in many companies but the results often disappoint; the time taken to build models is often too long, the models too detailed and cumbersome, and the final model ultimately not **fit-for-purpose**. This course tackles the reasons why and offers **remedies to fix these problems**.

Learning Outcomes

Participants will learn to:

1. Form a fluid-sensitive conceptual model for a heterogeneous reservoir, built from a selection of elements and placed in a realistic architectural framework: 'the sketch'.
2. Evaluate which rock modelling algorithms to select in order to digitally realise the desired architectural concept.
3. Explore an intuitively-guided use of geostatistical tools, balancing deterministic and probabilistic components and with awareness of the limits of the tools.
4. Select appropriate methods for property modelling, including the handling of 'net' (cut-offs vs. total property modelling) and the handling of porosity and saturation.
5. Understand the issues surrounding permeability modelling and why this differs from the handling of other properties.
6. Understand standard options for upscaling of properties, both for single phase and multi-phase systems.
7. Explore options for multi-scale modelling and determine the need for multi-scale approaches based on a hierarchical understanding of (REV) Representative Elementary Volumes.
8. Review options for model-based uncertainty-handling (base-case led, multi-deterministic, multi-stochastic), and how to select an appropriate workflow which minimises the impact of behavioural heuristics and biases.
9. Complete a reservoir model design for a synthetic field case, fit-for-purpose and ready for input to a dynamic reservoir engineering simulation.

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Training Method

This is a combined field- and class-based event, combining classroom talks and discussion with access to excellent field analogue outcrops in SW Wales. This course will also make use of virtual outcrop imagery.

Modelling and simulation software is not run live on the event – the emphasis is on good design. However, models and simulations of the Pembroke Field have been built at a number of scales and will be shown to quantify the impact of the observed field heterogeneities on fluid flow.

Physical Demand

The physical demands for this course are **LOW** according to the Tetra Tech RPS field course grading system; the course requires basic fitness levels. Fieldwork takes place along coastal sections, involving walks of up to 2.5 km (1.55 miles) at a single locality. On one of the field days, the total cumulative hiking distance can reach up to 6 km (3.72 miles). These hikes follow coastal paths with maximum ascents of 30 m (98 ft), and include walking along sandy or pebbly beaches, as well as some scrambling over rocky foreshore areas. SW Wales has a temperate climate, but weather conditions can vary throughout the day. Transport will be by coach on paved roads.

Who Should Attend

Geoscientists with some knowledge of reservoir modelling; Petrophysicists who provide input to static reservoir models; Reservoir engineers involved in simulation work who deal with the static-dynamic interface and upscaling on a regular basis. Multidisciplinary asset teams would benefit from attendance as a group. The course is also of benefit to team leaders who wish to have a deeper understanding of the principles behind modelling, and any subsurface staff involved in the QC of models made by others.

Course Content

The central theme of the event is Reservoir Model Design, on the premise that it is design rather than software knowledge that typically distinguishes ‘good models’ from ‘bad models’. This is organised around the following five themes, issues within which are often the cause of a poor model outcome:

1. Model purpose – why are we logged on in the first place and what is the question we are specifically trying to address? The size and scaling of the model and the statistical handling of raw data differ depending on the ultimate model purpose.
2. Elements and architecture – how much detail should be incorporated in the models? From the rich spectrum of potential lithofacies, electrofacies, biostratigraphic and analogue data inputs, how do we select the ‘right’ number of components (elements) to take forward into the modelling process? Once selected, how do these elements combine into a realistic description of length scales and reservoir architecture? Indeed, is there a clear, fluid-sensitive reservoir concept at all; can it be sketched?

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3. Probability and determinism – is the balance of probabilistic and deterministic components appropriate given the model purpose? Should heterogeneities be handled implicitly or explicitly in the static and dynamic models? What are our expectations of geostatistics and how do we control the algorithms intuitively to replicate a reservoir concept?
4. Multi-scale modelling – what scale should we be modelling and simulating at given the fluid type and model purpose? Can everything be modelled at one scale, or are static/dynamic multi-scale models required? We address the full spectrum of heterogeneity using the concept of Representative Elementary Volumes and conclude that traditional static-dynamic upscaling is only part of the story, and not always the main part.
5. Model-based uncertainty-handling – how to really go wrong. What are the tools we can use to identify natural bias in the modelling process and select workflows which capture useful ranges in a practical way, minimising bias in the process. We summarise the current range of stochastically- and deterministically-led options, and discuss which is appropriate to use, and when.

Location and Itinerary:

The course is based in Saundersfoot, an excellent venue well-situated for easy access to a wide range of analogue reservoir outcrops. Field locations include Amroth, Manorbier, Freshwater, and Saundersfoot itself. At least one location will be visited each day, with each day starting and finishing in the classroom. Exact timings will depend on tide times and weather. The itinerary and content can also be flexible to meet the interest areas of the group.

Day 0: Pick up from Heathrow and road transfer to Wales (typically 4 hours)

Day 1: Model purpose, elements and architecture

Day 2: Rock modelling, probability and determinism, practical geostatistics

Day 3: Property modelling, handling permeability and fractures

Day 4: Dealing with scale: upscaling, multi-scale modelling and the REV

Day 5: Model-based uncertainty handling; completing the Pembroke model design and debriefing with reservoir and simulation models.

Day 6: Return to Heathrow and departure