N012: Reservoir Modelling Field Class *(Utah, USA)*

Instructor(s): Richard Steele and Karl Stephen

Format and Duration

Field - 5 Days
Moderate Physical Demand

Summary

This course examines the workflow from geocellular modelling to flow simulation, seeking to treat reservoir modelling as a single, shared subject. We educate geoscientists in reservoir engineering and petroleum engineers in reservoir geology in the context of the shared methods and objectives of reservoir modelling. Participants work a series of exercises in teams based on high-quality outcrops, considering and developing each as a modelling exercise. Our examples are conventional sandstone reservoirs. Bad reservoir models destroy or deny value in their downstream products: decisions, development plans and production forecasts. Most companies have examples hidden in the archives – field developments that are under-sized, over-sized, badly-designed or just plain uneconomic. This class aims to educate to avoid those ugly outcomes. It provides reservoir engineers with the geology and geologists with the reservoir engineering to recognise when the defaults lead to undermodelling (i.e. models that lack critical elements of the flow structure) and to ask, "Ok, we built the model. Now, what's wrong with it? What might be missing that would mess the forecasts?"

Learning Outcomes

Participants will learn to:

1. Assess how best to represent in reservoir models the flow and storage properties of rocks and fluid-flow processes
2. Judge the weaknesses of present reservoir modelling methods and how to mitigate those deficiencies by appropriate model design and workflow choices
3. Assess the geological requirements of geomodels, the reservoir engineering requirements of flow simulation models in both depletion and displacement recovery and the dilemmas that have to be resolved to create effective reservoir models
4. Actionable geological representations as a basis for geomodel design, giving appropriate consideration to fluid type, recovery process, geology and the petroleum engineering challenge
5. Assess fault geometry, fault rock properties, fault seal and structural geological controls on reservoir complexity, and how these are incorporated into reservoir models.

Training Method

A five-day field course in Utah with lectures and classroom exercises. The proportion of field and classroom time is approximately 70/30.

We use outcrops and models to show geologists what is important for flow, why some geology should be ignored and to show reservoir engineers why that assessment can be complicated. Tutor Steele is a geologist; tutor Stephen is a reservoir engineer.

The culminating exercise requires teams to make a field development plan based on an oilfield-sized outcrop and a set drilling budget. The resulting plans are modelled and ranked on Net Present Value and Ultimate Recovery. Much learning results. Entertainment too, because participants tend to be competitive

and we have an archive of development plans going back a decade.

The teaching is supported by a comprehensive Field Guide and separate Course Manual.

Physical Demand

The physical demands for this class are MODERATE according to the Nautilus Training Alliance field course grading system. The fieldwork will involve walking up and down slopes over rough ground. There will be walks of up to a mile on most days, the longest being an ascent (and descent) of 60 m (200 ft) over rocky ground as part of a walk of 3 km (2 miles). The altitude of the field area ranges from 1200-1750 m (4000-5800 ft), which may lead to unexpected shortness of breath for some. The weather should be pleasant, but early-morning temperatures will be below 5 degrees Celsius on some days. Driving will be in SUVs on black-top and unpaved roads.

Who Should Attend

This course is multi-disciplinary. It is designed for geoscientists, petroleum engineers and petrophysicists involved in designing, building and assessing reservoir models. The team exercises will include a mixture of participants from different subsurface disciplines.

Prerequisites and Linking Courses

Participants should have a basic understanding of reservoir geology and reservoir engineering. For more experienced subsurface staff who have been involved in field appraisal and development, N412 (A Critical Guide to Reservoir Appraisal and Development) taken before N012 would complement the field course well. N058 (Reservoir Characterisation and Geostatistical Modeling in Field Development) is a classroom and computer- based counterpart to N012. N427 (Reservoir Model Design, Pembrokeshire, UK) follows on from N012 in the curriculum. N033 (Characterisation, Modelling, Simulation and Development Planning in Deepwater Clastic Reservoirs, Tabernas, Spain), N108 (Exploration and Geological Model Development in Fluvial Reservoirs, Ebro Basin, Spain) are also recommended as follow-up courses to review field-based reservoir development and modelling analogues.

Course Content

The excellent and famous exposures of diverse sandstone formations of the Colorado Plateau provide an exceptional field laboratory for the investigation of reservoir architecture, heterogeneity and compartmentalisation.

The exercises on the class follow a pattern:

1. Make geological observations and interpretations at superb outcrops with a focus on properties

affecting fluid flow and storage
2. Explain how the geology works and show how it would flow using the output of a reservoir model constructed from the outcrop, picking out thematic sets of sensitivities
3. Debate questions of reservoir model design, with due reference to fluid and recovery process
4. Build follow-up reservoir engineering and geology tutorials out of each exercise

The exercises are configured and coordinated to show the widest range of geological and petroleum engineering topics that can be fit into 5 days.

The geoscientists get to understand the flow properties better, the reservoir engineers learn relevant geology and all participants improve their knowledge of the modelling workflow.

Itinerary

Day 0:
Outward travel and overnight in Grand Junction, Colorado

Day 1:

- Introduction to the field area; logistics, HSE; how the class works
- Current challenges in reservoir modelling
- Flow modelling themes
- Fieldwork: regional overview and the set-up amid the spectacular scenery of the Colorado National Monument. How geologists make up their pausible fairy stories about rocks and how reservoir engineers apply the maths of fluid flow in porous media, including the results of a flow model of the outcrop at the outcrop.

Overnight in Green River, Utah

Day 2:

- Fieldwork: gathering data to understand the reservoir architecture of the Grassy Member, a shoreface sandstone; a model of the outcrop at the outcrop
- Classroom: Assembling those data for field-scale reservoir modelling

Overnight in Green River, Utah

Day 3:

- Classroom: Finalising models; presentations; discussion around the previously prepared geomodel and the simulator
- Fieldwork: Gathering outcrop data: shoreface, incised-valley fills and alluvial sandstones of the

Desert and Castlegate; building a pattern-scale model
- Team presentations at the outcrop

Overnight Moab, Utah

Day 4:

- Classroom: Follow-up presentations to Day 3, introduction to Day 4
- Fieldwork: Fault characterisation and modelling: The Moab Fault
- Observing faults with throw from 1 mm to 1 km; intra-reservoir faults and reservoir-bounding faults and their effects on fluid flow

Overnight Moab, Utah

Day 5:

- Fieldwork: Mixed fluvial, lacustrine and aeolian reservoirs of the Cutler Formation
- Fieldwork exercise: replicating the development of a marginally economic field. Teams will be given a drilling budget and asked to devise a development plan
- Team presentations at the outcrop
- Classroom: Simulation results based on the development plans: which is best? Followed by a summary presentation then dinner in Grand Junction.

Overnight Grand Junction, Colorado

Day 6:

Homeward travel