Natural Fractures (Faults and Joints): Quantification and Analysis, Somerset, UK (G033)

Tutor(s)

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Overview

This course will explore superb exposures of fault and joint systems within the Triassic/Lower Jurassic of the East Bristol Channel and Central Somerset Basins, focusing on 3-D seismic scale fault systems, including a variety of fracture geometries, fabrics and networks. Field analysis will be supported by materials on stress, strain and fracture development, as well as an analysis of both seal potential and flow potential. Key challenges regarding predicting fracture volumetrics and the challenges of fault seal will be addressed, including how to bridge the gap between outcrop detail and seismic structures and how to represent fractures in reservoir models, whether they be sealing or conductive to flow.

Duration and Logistics

5 days; a mix of field visits (50%) and classroom lectures with exercises (50%).

Exertion Level

This class requires an **EASY** exertion level. Somerset is quite comfortable in the spring and early summer, with temperatures of 5–20°C (40–65°F) and occasional rain showers. Field stops require short walks along coastal paths, beaches and wave cut platforms. The longest walk is <4km (2.5 miles). Field stops are all at approximately sea level and some are tide dependent. Transport will be by coach.

Level and Audience

Fundamental. The course is designed for geoscientists, petrophysicists, reservoir engineers and well engineers. Ideally structured for groups working in multi-discipline, asset-based teams with structurally complex reservoirs wishing to understand fracture properties and their impact on fluid flow.

Objectives

You will learn to:

1. Characterize fracture systems and geometries in the subsurface.
2. Quantify fault properties, including sealing capacity and threshold pressure.
3. Quantify open natural fracture properties.
4. Address modeling challenges for fracture type and fracture property distribution.
5. Represent fractures (both faults and joints) in reservoir simulations.
6. Evaluate risk and uncertainty associated with fracture modeling.
7. Evaluate the impact of fractures on well planning and seal integrity.

Course Content

Course Details

Fault systems exposed on the North Somerset foreshores deform Triassic to Lower Jurassic stratigraphy and are located on the southern margin of the Mesozoic to Tertiary, E-W and NW-SE trending East Bristol Channel and Central Somerset Basins. These basins link the Main Bristol Channel Basin with the western part of the Wessex Basin located to the east.

The region as a whole offers an excellent backdrop for the inclusion of a variety of fracture-related themes including:

- Methods for quantification of fault zone properties
- Sealing capacity and threshold pressure
- Impact on well design (trajectories) and well planning
- Mapping and QC of mapped fault networks
- Representation of open fault damage zones in reservoir simulations
- Risking and uncertainty based on understanding of fault seal and trap analysis
- Well planning in compartmentalized reservoirs
- Impact on exploration, appraisal and development decisions in E&P

Triassic strata comprise a series of red mudstones and siltstones laid down in playa lake settings, these overlain by lacustrine and marine gypsiferous marls, siltstones, sandstones and dolomites of the Blue Anchor Series. Rhaetian marine mudstones and finally marine marls and limestones of the Blue Lias Formation of the Lower Jurassic complete the transgressive sequence.

Fieldwork will focus on two key outcrop locations at Kilve and Watchet.

3-D examples of extensional fault systems are exposed in the cliffs and on the foreshore at Kilve in North Somerset. Extensional faults range from a few meters to several hundred meters in strike-lengths and occur in dark colored shales and interbedded limestones. The limestones display text-book joint patterns – analogues for type 1 and 2 naturally fractured reservoirs.

Extensional and inverted fault systems are also exposed in the cliffs and on the foreshore at Watchet in North Somerset along the southern margin of the Bristol Channel. Inverted Upper Jurassic extensional faults juxtapose grey Lower Jurassic (Lower Lias) shales and interbedded limestones against the red Upper Triassic Mercia mudstones.

Day 1: Arrive in Holford

Arrival into Bristol Airport and transfer to Holford, Somerset.

Day 2: Faults

The class begins with a short introductory lecture and course safety briefing.

Classroom:

Faults as structural elements

- Fault properties (beyond “open or closed”)
- Faults vs joints
- Hybrid fractures
- Fault terminology
- Faults as volumes
- Fault related fracturing
- Damage zones

Fieldwork:

- Watchet

Day 3: Fault Seal

Classroom:

Fault seal components (inside a gouge)

- Fault seal processes
- Layer juxtaposition
- Lithological mixing
- Cementation
- Clay smear
- Shale Gouge Ratio

Fieldwork:

- Kilve

Day 4: Fault rock permeabilty

Classroom:

Fault rock permeability

- Measured fault rock permeabilities
- The Sperrevik relationships

Faults-Baffles, Barriers or Conduits

- Fault seal
- Relative permeability effects
- Production behaviour

Fieldwork:

- Klive

Day 5: Departure

Classroom:

Course summary and wrap up

Return to Bristol Airport for flights home.