

Applied Concepts of Natural Fractures: Mechanics and Characteristics in Outcrop and Core, New Mexico (G049)



Tutor(s)

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Overview

Outcrops in central New Mexico offer excellent examples of natural fractures in a variety of structural settings and lithologies. They illustrate the mechanical and stratigraphic controls on the fracture systems that in turn control permeability in most conventional and unconventional reservoirs. A world-class example of permeability-reducing shear fractures (“deformation bands”) will be visited, occurring in fluvial sandstones of the Morrison Formation. The outcrops to be visited also show fractures associated with faulting, as well as the complications associated with reactivation of extension fractures in shear. An exposition of the authors’ 65-piece teaching collection of natural and induced fractures in core is part of the course, providing the chance to compare one-dimensional core fracture data with the three-dimensional data provided by outcrops.

Duration and Logistics

5 days; a mix of classroom lectures (15%), field time (75%) and core/hand sample workshop (10%). The course begins and ends in Albuquerque, New Mexico.

Level and Audience

Advanced. This course is intended for geoscientists, reservoir and production engineers, and petrophysicists who need to characterize and understand fracture systems and their effects on reservoir permeability from core and outcrops; who need to be able to differentiate between natural and induced fractures in cores; and who would like to be able to predict the effects of lithology on fracturing. It is also for those who want to understand fracture permeability in relationship to the in situ stress system, the interaction of natural fractures with hydraulic stimulation fractures, and the important differences between extension and shear fractures in controlling individual fracture permeability and fracture network interconnectedness.

Exertion Level

This class requires a **MODERATE** exertion level. The fieldwork will involve walking up and down slopes over rough ground. There will be walks of up to 1.6km (1 mile) on most days, the most strenuous being an ascent (and descent) of 60m (200 ft) over rocky ground as part of a walk of 3km (2 miles). The elevation range is 1600-2200m (5300-7200 ft), which may lead to unexpected shortness of breath for some. The central New Mexico weather in the fall is cool-warm and dry, and often windy. Transport is by SUVs. Most driving is on black-top roads, but some areas are reached by gravel or dirt roads.

Objectives

In this hands-on, application-based field trip you will learn to:

1. Assess the origins of fractures.
2. Understand characteristics and distributions of different types of natural fractures and their potential effects on reservoir permeability.
3. Differentiate fractures by type, as well as predict what fracture types to expect in different structural domains and reservoirs, through discussion on the outcrop.
4. Assess the interactions between natural fractures, in situ stresses and stimulation fractures.
5. Appreciate the wide range of structures that fall under the basket term “fracture”, and recognize that different fracture types do not have the same effect on hydrocarbon reservoirs.

Course Content

Day 1: Arrive in Albuquerque

Classroom:

- Course introduction and safety briefing
- Introduction to local stratigraphic section

Overnight in Albuquerque.

Day 2: Fractured Carbonates

Classroom:

- Fracture types
- Introduction to fracture mechanics

Fieldwork:

- Outcrops east of Albuquerque – fractures in Paleozoic carbonates and sandstones
- Core viewing at the FractureStudies LLC hangar
- Fractures associated with faults and folds

Overnight in Albuquerque.

Day 3: Fractured Sandstones

Fieldwork:

- Fractures in Mesozoic sandstones and shales in the vicinity of the normal and wrench faults and their associated fracture systems near San Ysidro, NM.
- Conjugate and amalgamated deformation bands in the Morrison Formation.
- Superimposed fracture systems in the Dakota Sandstone.
- Fractures in the Mancos shale, fracture halos on faults and fractures in folded strata.

Overnight in Santa Fe.

Day 4: Extension Fractures

Fieldwork:

- Sheared extension fractures, deformation bands and faults in Mesozoic sandstones at Abiquiu Lake and along the Chimney Rock trail at Ghost Ranch.
- Discuss fracturing across the San Juan basin as a result of north-south tectonic compression related to the San Juan uplift.

Overnight in Santa Fe.

Day 5: Departure

Return to Albuquerque and travel home.