N381: Influence of Tectonics and Mechanical Stratigraphy on Natural Deformation in the Permian Basin *(Texas, USA)*

Instructor(s): David Ferrill and Kevin Smart

5 Days	Competence Level: Skilled
Field Course	
Classroom Elements	
LOW	Low Physical Demand

Summary

This field seminar will explore natural deformation in Permian strata in and around the Permian Basin in west Texas. Participants will investigate mechanical stratigraphy and the regional tectonic setting provides the context for understanding deformation features such as joints, shear fractures, folds, faults, and stylolites. Outcrop observations will be tied to the deformation conditions under which they developed, and will be related to the subsurface (logs and stress data) to illustrate the critical importance of understanding deformation in the subsurface, including both pre-existing natural deformation and as analogs for deformation produced by induced hydraulic fracturing.

Learning Outcomes

Participants will learn to:

1. Characterize mechanical stratigraphy based on lithostratigraphy and rock strength information.
2. Assess stress conditions from small-scale deformation features.
3. Relate deformation style to tectonic setting of the Permian Basin, including influences of Ancestral Rockies, Ouachita, Laramide, and Basin and Range orogenic events.
4. Assess the role of mechanical stratigraphy, stress conditions, and pre-existing deformation features on rock behavior, including fracture prediction in unconventional and conventional reservoirs.
5. Evaluate the behavior of lithological units under different well completion strategies.
6. Evaluate geomechanical issues for common petroleum and unconventional resource applications such as well design, borehole stability, and hydraulic fracturing.

Duration and Training Method

A Five-day field seminar starting and ending in Midland, Texas. The proportion of field time to classroom time will be 9:1.

Physical Demand

The physical demands for this class are LOW according to the Nautilus Training Alliance field course grading system. Fieldwork is in west Texas, where the climate tends to be warm-hot and dry. Transportation is by SUVs. Most driving is on black-top roads, and most outcrops are adjacent to roads.

Who Should Attend

The course is aimed at geoscientists, petrophysicists, reservoir engineers and production engineers working in mechanically layered, deformed rocks in the Permian Basin or other relatively gently deformed sedimentary basins. It will be of particular interest to individuals working in unconventional reservoirs within the Permian Basin.

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Prerequisites and Linking Courses

A basic awareness of structural geology and of resource plays, such as presented in N016 and N116 (Structural Geology for Petroleum Exploration) and in N313 (Evaluating Resource Plays: The Geology and Engineering of Low Permeability Oil and Gas Reservoirs), is desirable but not essential.

Related courses include N114 (Extensional Tectonics and Normal Faulting,Nevada and California, USA), N134 (Carbonate and Shale Faulting and Fracturing, Texas, USA), and N266 (Stress and Geomechanical Analysis,Texas, USA).

Course Content

The course will be primarily field-based with some classroom and core facility exercises. The course will explore outcrops around the margins of the Permian Basin including the Eastern Shelf (eastern edge of Permian Basin), Glass Mountains (southern edge of Permian Basin), and the southeastern Guadalupe Mountains (western edge of Permian Basin). The variety of rock types and the locations at the western, southwestern, and eastern edges of the basin provide examples of the major tectonic influences important in the subsurface of the Permian Basin hydrocarbon plays. Itinerary

Day 0

- Arrive in Midland and travel to San Angelo, TX
- Overnight in San Angelo, TX

Day 1

- Introductory lectures on regional geology and basic concepts of faulting, fracturing and mechanical stratigraphy
- Field trip to outcrops of Permian strata in the Eastern Shelf in the general vicinity of San Angelo, TX
- Overnight in San Angelo, TX

Day 2

- Field trip to outcrops of Pennsylvanian/Permian strata in the southern Permian Basin (Val Verde Basin) in the area of Marathon, Texas
- Overnight in Marathon, TX

Day 3

- Field trip to outcrops of Paleozoic strata in the Marathon fold-thrust belt in the Marathon Uplift
- Drive to Van Horn, TX
- Evening lecture on induced hydraulic fracturing in mechanically layered unconventional reservoir

strata
- Overnight in Van Horn, TX

Day 4

- Field trip to outcrops of Permian strata in the western Delaware Basin in the foothills of the Guadalupe Mountains
- Overnight in Van Horn, TX

Day 5

- Field trip to outcrops of Permian strata in the western Delaware Basin in the foothills of the Guadalupe Mountains
- Drive across the Delaware Basin, Central Basin Platform, and Midland Basin to Midland, TX
- Return home or overnight in Midland, TX.