

# Progressive Deformation in the Arbuckle and Wichita Mountains: Implications for Mid-Continent and Resource Plays, Oklahoma (G083)



## Tutor(s)

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## Overview

This field seminar will explore natural deformation in Paleozoic rocks in and around the Wichita and Arbuckle uplifts in southern Oklahoma. Investigating 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 related to the subsurface (cores, 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.

## Duration and Logistics

A 5-day field course, comprising a mix of field exercises (85%) and classroom work (15%). The course will start in Lawton, Oklahoma, and end near Ardmore, Oklahoma.

## Level and Audience

**Intermediate.** The course is aimed at geoscientists, petrophysicists, reservoir engineers and production engineers working in mechanically layered, deformed rocks in Oklahoma or other relatively gently deformed sedimentary foreland basins. It will be of particular interest to any geoscientists, petrophysicists and engineers working in unconventional reservoirs, including those in the Anadarko Basin.

## Exertion Level

This course requires an **EASY** exertion level. Fieldwork is in southern Oklahoma, where the climate can be variable according to the season. Transportation is by SUVs. Most driving is on black-top roads, and most outcrops are adjacent to roads or within inactive quarries with uneven ground, where long strenuous hikes are not needed to access the exposures.

## Objectives

You will learn to:

1. Identify small-scale deformation features that are common in the SCOOP/STACK plays of the Anadarko basin and other unconventional reservoirs.
2. Interpret stress conditions and stress evolution from small-scale deformation features.
3. Characterize mechanical stratigraphy based on lithostratigraphy and rock strength information.
4. Relate deformation styles to the tectonic setting of southern Oklahoma.
5. Assess the role of mechanical stratigraphy, stress conditions and pre-existing deformation features

on rock behavior, including fracture prediction in unconventional and conventional reservoirs.

6. Consider, in general terms, the behavior of lithological units under different well completion strategies.
7. Evaluate geomechanical issues for common petroleum and unconventional resource applications such as well design, borehole stability and hydraulic fracturing.

## Course Content

### Course Details

The course will be primarily field-based with some initial classroom time. The course will explore outcrops in the Wichita and Arbuckle uplifts, and discuss relevance to deformation in and around the Anadarko Basin. The variety of rock types and the locations along the southwestern edge of the Anadarko Basin provide examples of the major tectonic influences and rock deformation responses, including progressive deformation that can inform interpretations of the subsurface hydrocarbon plays.

### Day 1: Arrive in Lawton

Classroom:

- Course introduction and safety briefing

*Overnight in Lawton, Oklahoma.*

### Day 2: Introduction and Field Excursion to Wichita Mountains

Classroom:

- Introductory lectures covering basic concepts of faulting, fracturing and mechanical stratigraphy, and regional tectonic setting

Fieldwork:

- Field excursion to explore basement rock outcrops in and around the Wichita Mountains (Wichita Mountains Wildlife Refuge)
- Mount Scott Granite with igneous dikes
- Unconformity at the top of the Mount Scott Granite, and the overlying Post Oak
- Conglomerate (igneous sourced clasts)

*Overnight in Lawton, Oklahoma.*

### Day 3: Field Excursion in the Slick Hills and travel to Ardmore, Oklahoma

#### Fieldwork:

- Field trip to outcrops in the Slick Hills to explore mesostructural assemblages in Paleozoic strata related to the Wichita Uplift
  - Opening-mode fractures in the Cambrian Honey Creek Formation and Fort Sill Formation
  - Igneous dike cutting Carlton Rhyolite
  - Post Oak Conglomerate (carbonate-sourced clasts)
  - Opening-mode fractures, veins, tectonic stylolites and shear fractures (small faults) with slickenlines in Ordovician carbonates

*Overnight Ardmore, Oklahoma.*

### Day 4: Field Excursion in the Arbuckle Uplift

#### Fieldwork:

- Field trip to outcrops of Paleozoic strata in and around the Arbuckle Mountains - explore 3-dimensionality of deformation, stress history, and progressive deformation in the backlimb and upright forelimb of Arbuckle anticline
  - Opening-mode veins (asphalt-filled) and mesoscale folds in the Woodford Shale
  - Opening-mode fractures (joints, veins), thrust faults, slump folds, contractional box folds, mesoscale folds, tectonic stylolites in Ordovician carbonate strata in backlimb of Arbuckle anticline
  - Fault-related folding in the upright forelimb of the Arbuckle anticline
  - Collings Ranch Conglomerate and normal-faulted unconformity

*Overnight in Ardmore, Oklahoma.*

### Day 5: Field Excursion in the Arbuckle Uplift and Depart

#### Fieldwork:

- Field trip to outcrops of Paleozoic strata in and around the Arbuckle Mountains - explore 3-dimensionality of deformation, stress history and progressive deformation in the overturned forelimb of Arbuckle anticline
  - Woodford Shale - fractures, faults, folds in overturned forelimb Arbuckle anticline
  - deformation (fractures, veins, wedge thrusts and strike-slip faults) in Viola Group, within overturned forelimb of Arbuckle anticline
  - Fractures, wedge thrusts, mesoscale folding and 'Arbuckle Mountain Fried Pies' - Sylvan Shale, Hunton Group and Sycamore Limestone in the overturned forelimb of the Arbuckle anticline

*Depart for Oklahoma City to arrive in time for evening travel home.*