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## N114: Extensional Tectonics and Normal Faulting (*Nevada and California, USA*)

Instructor(s): David Ferrill / Kevin Smart / Adam Cawood

### Format and Duration

Field - 5 Days

Moderate Physical  
Demand

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## Summary

This advanced structural geology course provides geoscientists with hands-on experience analyzing complex structures at the reservoir scale. The course focuses on extensional fault systems and the interplay between normal faults and strike-slip faults to accommodate transtensional deformation. The course begins in Reno; traverses Owens Valley, Panamint Valley, and Death Valley; and ends in Las Vegas.

## Learning Outcomes

Participants will learn to:

1. Appraise complex extensional structures analogous to those that control hydrocarbon migration and trapping in petroleum provinces around the world.
2. Evaluate subtleties of structural style.
3. Judge the strengths and weakness of interpretations of extensional fault systems.
4. Propose alternative interpretations based on the range of fault patterns observed.
5. Assess deformation mechanisms that operate in fault zones.
6. Evaluate and integrate structural uncertainty in risk assessment.
7. Characterize the regional tectonic setting, stratigraphy and development of the western Basin and Range, USA.
8. Judge how fault system geometry, timing and topology affect hydrocarbon migration and trapping.
9. Judge the complexity of fault scaling relationships (i.e. the interplay of fault displacement, length and timing).
10. Assess field examples of many of the extensional fault system features they will encounter during interpretation of seismic and well data.

## Training Method

This course is conducted principally in the field through observation and collection of data for exercises. A half day is spent in the classroom on the first day.

## Physical Demand

The physical demands for this class are **MODERATE** according to the Tetra Tech RPS field course grading system. Field stops are in a mountainous, arid environment where temperatures range from cool to hot. The longest walk on the class is approximately 3 km (2 miles) with an ascent (and descent) of 300 m (1000 ft). There are walks of up to 1 km (0.6 miles) most days. Trails are generally smooth but can be rocky underfoot in places. The field area is at elevations from below sea level to 2500 m (8000 ft), which may lead to unexpected fatigue or shortness of breath for some participants. Transport is by SUVs. Most driving is on black-top roads, but some outcrops are reached via well marked dirt roads. The total



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distance driven on this course is about 1600 km (1000 miles).

### Who Should Attend

The course is aimed primarily at experienced exploration and production geologists and geophysicists who are interested in improving their understanding of extensional structural elements.

### Course Content

Exposures visited focus on extensional fault systems, extensional fault-bend folding, fault zone deformation mechanisms, fault scaling relationships and fault topology. The course also includes a broad overview of the structure of the western Basin and Range to provide regional context for the field localities.

#### Day 0:

- Fly into Reno, Nevada.

#### Day 1:

- Introductory lectures on extensional faulting concepts
  - Basics of fault systems and fault topology
  - Series of exercises interpreting faults on structure contour maps of the Volcanic Tableland of increasing data resolution
- Depart for Bishop, California
  - Field stops to discuss structural style and regional tectonic setting
- Spend night in Bishop

#### Day 2:

- Drive to east side of Owens Valley to discuss Owens Valley graben and regional tectonic setting
- Drive to east flank of Sierra Nevada for overview of Volcanic Tableland
  - structural setting of Volcanic Tableland
  - stress and fault system development
  - rollover geometry and growth faulting
- Volcanic Tableland field stops and exercises
  - Segmented normal fault, en echelon fault arrays, and relay ramps
  - Interactions of surface drainage patterns and fault system
  - Flipping faults
  - Southern Fish Slough fault system breached relay ramp hike
- Spend night in Bishop



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### Day 3:

- Check out of hotel in Bishop
- Owens River cutbank crossing faults cross-section exposure
  - Outcrop photograph restoration exercise
  - Discuss influence of faults on reservoir bulk permeability
- Drive to Death Valley, stopping along the way to discuss Owens Valley, Eureka Valley, Saline Range, Saline Valley and Panamint Valley structural/neotectonic setting
- Hike through Mt. Tucki detachment fault at Mosaic Canyon (due to park restrictions, the group may need to split up, with half going to Natural Bridge trail instead)
- Spend night at The Oasis at Death Valley

### Day 4:

- Hike through Death Valley normal fault on Natural Bridge trail (due to park restrictions, the group may need to split up, with half going to Mosaic Canyon)
- Drive to Dante's View
  - Overview of Death Valley regional tectonic setting
  - Discussion of pull-apart basins
- Steve's Pass – discussion of Crater Flat half graben and Yucca Mountain (former proposed site of high-level radioactive waste repository)
- Bare Mountain – discussion of fault geometry and fault-block deformation processes in an extensional imbricate fault system
- Drive through detachment fault footwall and across basin-bounding fault on Titus Canyon Road (if time, weather and road conditions permit)
- Spend night at The Oasis at Death Valley

### Day 5:

- Check out of The Oasis at Death Valley
- Drive to Badwater playa at range front between aggrading alluvial fans downthrown to Death Valley fault
- Copper Canyon and Mormon Point turtlebacks
- Lunch at "coal seam" near Shoshone, California
- Conclusion and drive to Las Vegas, arriving approximately at 5:30 p.m.