N041: Extensional Tectonics and Normal Fault Patterns *(Utah, USA)*

Instructor(s): Bruce Trudgill

Format and Duration

Field - 5 Days
Moderate Physical Demand

Summary

This course is a field, lecture and practical based investigation of extensional tectonics and normal fault patterns in the northern Paradox Basin, SE Utah, aimed at both geoscientists and engineers. Participants examine the superbly exposed, salt-detached, fault and relay ramp structures of the northern Paradox Basin and the Moab Fault system. Comparisons with subsurface analogues will be made throughout the course, and implications for trap development and reservoir compartmentalization discussed.

Business impact: Incorrect mapping of linked fault systems is common across the petroleum industry. In a workstation environment, faults are often only interpreted as simple sticks on vertical seismic profiles, with scant regard for their geometry and complexity in 3D. This course aims to improve understanding of linkage within normal fault systems through analysis of world-class examples of relay and breached relay ramps. Participants can then integrate these field-based models into their subsurface interpretations, thereby increasing their chances for exploration success and decreasing chances of unpleasant surprises during development drilling.

Learning Outcomes

Participants will learn to:

1. Assess the stratigraphy and principal structural controls on the Paradox Basin, SE Utah.
2. Appraise the role of salt tectonics on the development of major fault systems in the region.
3. Evaluate the mechanisms of faulting, fault propagation, and the controls on the size, distribution, and population of normal faults.
4. Analyze, through superbly exposed field examples the geometry and evolution of relay ramps and breached relay ramps.
5. Propose sub-seismic fault populations and understand the impact of near-fault deformation on reservoir compartmentalization and fault seal in high porosity sandstone reservoirs.
6. Scale-up evolutionary models of normal fault growth and basin filling mechanisms to large-scale rift basins.
7. Apply field-based models to improve seismic interpretation of linked faults systems in the subsurface and develop methodologies for defining structural traps.

Training Method

This is a field course, supported by classroom sessions in a 70:30 ratio. Classroom sessions comprise a mixture of presentations, practicals using seismic data and analysis of field examples. Attendees are encouraged to bring their own data for discussion.

Physical Demand

The physical demands for this course are MODERATE according to the RPS field course grading system; the course requires good general fitness levels. This is primarily due to the altitude (4,000-4,500 ft/ 1000-

1200 m) and prevailing hot and dry conditions in the field area. There are several hikes of around 3 miles (5 km) with up to 660 ft (200 m) of elevation gain. The remainder of the field localities involve walking a few hundred yards/metres with little significant elevation gain. One day involves a long drive into Canyonlands National Park in specialist Jeeps, which can be hot and uncomfortable. On this day the group is expected to be out for around 14-15 hours.

Who Should Attend

This multi-disciplinary course is designed for: (i) exploration and development geologists and geophysicists concerned with the exploration and exploitation of clastic reservoirs in extensional settings (ii) reservoir and production engineers seeking more information about compartmentalization and fluid-flow in relay ramp settings and (iii) asset managers responsible for exploitation of clastic reservoirs in rift basins world-wide.

Course Content

The focus of the course will be on the structural development of extensional basins and controls on stratigraphic sequences that develop in rifts. We will examine the causes of crustal extension and the mechanisms, geometries, scale and growth of normal faults. Rift basin models and the effects of fault evolution on depocentre and stratigraphic development are addressed in detail. Instruction at outcrop, with field and practical exercises complements the theoretical background presented in classroom lectures.

Below is a provisional course itinerary, which may vary depending on prevailing weather conditions.

Day 0
Participants arrive in Grand Junction

Day 1
Drive from Grand Junction to Moab with overview stops on route (Dead Horse Point - Overview of Canyonlands stratigraphy and the seismic scale of basin structures).

Day 2
Morning field excursion – examination of the structure of the Spanish Valley-Moab area. Afternoon lectures - introduction to course lectures and practicals, mechanisms of faulting, relay ramp development and evolution rift basin models, geometry of extensional faults, seismic interpretation of normal faults, Fault interpretation and correlation exercises.

Day 3
Fieldwork all day – examination of the structure of the Moab Fault zone using transects of the fault to study fault zone geometry, relay ramp and breached relay ramp geometries, associated structures and variation in fault rocks. Discussion of fault seal attributes of the Moab fault zone, fluid flow across the fault.

Day 4

An early start allows a full day in the Canyonlands Grabens system, Canyonlands National Park for a detailed analysis of relay ramps, breached relay ramps, and the control of fault growth on drainage patterns and sedimentation.

Day 5

A late morning start after the long Canyonlands day with the rest of the day spent on a field excursion to Arches National Park to study small scale deformation in sandstone reservoirs, reservoir compartmentalisation, hanging wall rollover geometries, and relay ramp deformation. Drive from Moab to Grand Junction and end of course dinner.

Day 6

Departure