TETRA TECH RPS ENERGY | TRAINING

N388: Structural Geology for Oil and Gas Industry Geoscientists

Format and Duration
Classroom - 5 Days

Instructor(s): Richard Jones

Summary

This course is designed to cover structural geology topics relevant for petroleum exploration, development, and production. It introduces the conceptual models behind structural interpretation and then builds skills, using different data sets, to explore basin scale- and prospect/field scale-analysis. Topics include interpretation of extensional, compressional, strike-slip, inversion and salt structures. Fracturing and reservoir scale geomechanics will also be explored.

Learning Outcomes

Participants will learn to:

1. Understand expectations for different tectonic settings.
2. Illustrate structural models for extension, compression, strike-slip, inversion and salt deformation.
3. Compare typical structures for different tectonic settings and their impacts on sedimentation.
4. Analyse typical fault geometries.
5. Understand and evaluate geological maps.
6. Build and balance structural cross sections and critically assess pre-existing cross sections.
7. Analyse basin histories from cross sections.

Training Method

A classroom course comprising lectures interspersed with practical exercise sessions including seismic interpretation. The exercises are designed to familiarise participants with the structural geologist's techniques. The exercises and case studies will combine surface and subsurface data including seismic, wellbore formation thicknesses and tops, cross sections, maps, satellite image data, and field photographs.

Who Should Attend

The course is designed for early-career geoscientists and geophysicists who have little experience with structural geology. Technical support staff may also find the course useful.

Course Content

Introduction: The importance of structural geology to the oil and gas industry.

Basin scale of analysis

- Geodynamic settings: Plate positions through earth history. Crustal scale responses to convergence / divergence / lateral slip and acquiescence (rheology and thermal structure of lithosphere). Examples of extensional, compressional and strike slip tectonics. Salt and gravitational tectonics.

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General terminology for faults and folds. Sediment accumulations in different tectonic settings (in terms of source, reservoir seal).

- Extensional structures: Models for rifting and passive margin evolution, (including lithospheric stretching models). Half graben and full graben. Rotated blocks, listric faults. Footwall uplift. Syn-rift, post-rift and sag sedimentary packages; deposition and subsidence. Analogue modelling. Common structural traps. Seismic and sub-seismic structures.
- Compressional structures: Regional fold and thrust belts. Fold and fault geometries and propagation. Thick and thin skinned structures; mechanical stratigraphy. Analogue modelling. Common structural traps. Seismic and sub-seismic structures.
- Strike slip regimes: Large scale long-lived strike slip faults. Transpression and transtension and associated structures (flower structures, pop-up structures, pull-apart basins, releasing and restraining bends), fault geometries, identifying associated structures on maps, satellite images and seismic data. Common structural traps. Seismic and sub-seismic structures.
- Inversion: Positive and negative inversions. Recognition on seismic, geometry in 2 and 3D. Common structural traps.
- Interplay between sedimentology and structure: Syn-sedimentary normal faulting and influence of faulting on sedimentary facies. Orogenic belts and sedimentary basins. Sand / shale responses to stress, mechanical stratigraphy.
- Basin history from cross sections: Inferring basin development from cross sections: significant fault activity, depocentre locations, fault reactivation, post rift subsidence. Comparison of basin history with geodynamics. Timing of structural activity relative to migration.
- Salt: physical properties, recognition in seismic, common structural traps including syn- sedimentary halokinesis. Mud diapers and volcanoes. Control on gravitational tectonics within passive margins.

Prospect/ field scale of analysis

- Faults: Interaction of faults and relay zones; structure of brittle faults; displacement profiles; sealing or leaking faults (shale gouge ratios, shale smear, Allen diagrams); synsedimentary faults; identifying timing of activity from seismic; subseismic faults (anticipated distributions and their impacts in different regimes); impact of pore fluid pressure.
- Fractures: How do they form / what are they associated with; models for distributions, orientations, intensities; intensities and orientations compared with fold mechanisms.
- Reservoir scale geomechanics: Fracture pressure, lithostatic pressure and fluid pressure, stress orientations around a well, current stress field, critically stressed faults, open fractures, borehole breakouts.
- Mapping subsurface structures: a checklist.