Seismic Structural Interpretation and Analysis Workshop (G005)

Tutor(s)

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Overview

The course addresses interpretation of 2-D and 3-D seismic reflection data for unraveling the geometry and kinematic evolution of crustal structures, principally in sedimentary rocks. Topics include understanding how structures manifest themselves in seismic data and approaches to effective interpretation and kinematic analysis. Structural systems addressed include extensional, fold and thrust belts, salt tectonics and inversion. Applied topics include interpretation and analysis approaches, determination of geologic and basin history, fault system analysis, fault permeability structure and geomechanical evaluations, such as in situ stress determination and application to induced seismicity risking. Practical exercises are based on global seismic datasets and are reinforced by active in-class discussion.

Duration and Logistics

Classroom version: A 5-day classroom course, comprising a mix of lectures (40%), analysis of case studies (30%) and integrated exercises (30%). The manual will be provided in digital format and participants will be required to bring a laptop or tablet computer to follow the lectures and exercises.

Virtual version: Ten 3.5-hour interactive online sessions presented over 10 days. A digital manual and exercise materials will be distributed to participants before the course. Some reading and several exercises are to be completed by participants off-line.

Level and Audience

Fundamental. The course is intended for geoscientists who wish to strengthen their seismic interpretation and analysis skills by applying key interpretation techniques and strategies to a wide range of structural types and application goals.

Objectives

You will learn to:

1. Understand the manifestation of 3-D structures in reflection seismic data.
2. Develop effective structural interpretation perception – learning to think ‘kinemechanically’.
3. Generate interpretations with geometric admissibility and kinematic compatibility.
4. Understand imaging scale, artefacts and interpretation pitfalls.
5. Gain experience in interpretation and analysis in all structural regimes.
6. Understand how faults form, grow, interact, reactivate and impact fluid flow.
7. Gain an introductory understanding of geomechanics as applied to interpretation.
8. Become acquainted with fault stress analysis and fault seal risking.

Course Content

Sessions 1 and 2: Introduction to interpretation

- Topics of applied seismic interpretation and application
- The components of a complete interpretation
- Introduction to mechanics of deformation
- Applying ‘kinemechanical thinking’ to interpretation
- Review of faults, folds and strain
- Recognizing detachments and ductile lithologic units
- Determining the timing of structural movement
- Interpreting lithologic units and mechanical stratigraphy
- Recognizing unconformities and basic sediment depositional geometries

Session 3: Reflection seismic data and interpretation pitfalls

- Understanding the basics of reflection imaging and processing
- Understanding normal-incident ray-paths and basic reflector geometries
- Understanding stacking vs time migration
- Understanding multiples and refractions
- Understanding seismic velocity, velocity effects and depth conversion

Session 4: Understanding stress and geomechanics for interpretation

- Understanding crustal stress and its representation
- Andersonian faulting theory
- Mohr-Coulomb failure analysis and rock strength
- Effective stress and influence of pore pressure
- Sliding friction and the Coulomb failure function
- Critically stressed fault hypothesis
- Interpreting stress – what can be calculated and what must be modelled and/or assumed
- Interpreting fractures and stress indicators from image logs

Session 5: Extensional faults and systems

- Development and evolution of normal faults, displacement and linkage
- Fault systems and how they evolve over geologic time
- Mechanical stratigraphy controls
- Folds associated with extension
- Using fold shape to discern fault geometry and evolution
- Fault system reactivation and obliquity
- Rift system anatomy and controls on 2-D and 3-D architecture
- Controls on subsidence and evolution systematics
- Fault stress analysis

Session 6: Rift systems

- Anatomy and geometry
- Basin development and subsidence

Session 7: Basement-rooted compression and inversion

- Anatomy and geometry
- Structural hierarchy
- Geometry and kinematics of oil-field-scale structures

Session 8: Basement-detached compression

- Critical wedge mechanics
- System geometry and kinematic evolution
- Geometry and kinematics of basement-detached compressional structures
- Imbricates, wedges and duplex systems and the role of mechanical stratigraphy
- Structurally linked systems and toe-thrust belts
- Spatiotemporal evolution of thrust systems
- 3-D geometry of thrust structures and faults

Session 9: 2-D geometric analysis and restoration

- Restoration and analysis workflows
- Rock deformation approximations and line-length restoration
- QCing interpretations by visual inspection
- Impact of critical assumptions
- Working with multiple hypotheses
- Utility of geometric analysis and restoration

Session 10: Salt-dominated structural systems

- Basic principles of salt mechanics
- Triggers of salt-system deformation and mobility
- Mechanisms controls on salt diapir rise and collapse
- Geophysical properties of salt and surrounding sediments
- Salt-surface reflectivity, migration and velocity considerations
- Methods of imaging salt structures
- Criteria for interpretation of the top and base of salt