N657: Seismic Structural Interpretation Techniques

Instructor(s): Douglas Paton

Format and Duration
Classroom - 5 Days

Summary

The aim of this course is to consider how the interpretation of seismic reflection data can be used in subsurface exploration of complex sedimentary basins with a focus on the interaction of sedimentary and structural evolution and the impact on hydrocarbon systems. It will provide an overview of the fundamentals of geophysical data interpretation and then consider the application in a suite of sedimentary basin settings. It will consider fault geometry, basin fill and implications for reservoir distribution and deformation. The class is taught through integrating recent advances in understanding of structural geology in the context of Basin Analysis, the integration of sedimentary deposition and structural geology and can be applied to both exploration and production settings.

Business Impact: Application of the learnings of this course will empower participants to acquire the knowledge and skills to effectively analyze seismic data, interpret structural features, and make informed decisions in exploration and production settings

Learning Outcomes

Participants will learn to:

1. Explain the key concepts and terminology related to seismic reflection studies in the context of structural analysis of basins.
2. Apply appropriate techniques and methodologies to conduct structural mapping in the context of frontier exploration, trap identification, and reservoir modeling.
3. Apply fundamental restoration techniques to constrain seismic interpretation.
4. Define and explain the concept of mega-sequences in the context of unconstrained basin settings.
5. Evaluate the importance of developing a robust conceptual model for understanding the kinematics, spatial distribution, and potential fluid pathways associated with normal faults in exploration and production activities.
6. Evaluate the significance of the interaction between normal faults and basin fill in controlling sedimentation patterns, stratigraphic architecture, and the distribution of hydrocarbon reservoirs.
7. Describe the process of constraining reverse fault geometry through fold identification and analyse its impact on reservoir distribution and compartmentalisation of hydrocarbon reservoirs.
8. Explain the fundamental principles and mechanisms of salt tectonics, including the origin and deposition of salt, its deformation behavior, and its influence on surrounding rock layers.
9. Evaluate the significance of 3D strike-slip tectonics in controlling basin evolution, fault interaction, and the development of geological structures in a regional or local context.
10. Illustrate the significance of multi-phase fault evolution in controlling basin architecture, fault geometry, and the distribution of hydrocarbon reservoirs in inversion tectonic settings.

Training Method

It is delivered over 5 days in a classroom with significant practical activities to ensure participants have the opportunity to apply their new knowledge. Each session is structured to be approximately 3 hours long and will comprise a combination of lectures (~1 hour) and practical material (~ 2 hours). Participants will

be expected to work up the practical exercises and present their findings either as individuals or within groups.

Using a combination of group exercises and individual exerises we consider how a key component of interpretation is an appreciation of the uncertainty inherent in the data. Throughout the course participants will be encouraged to present their observations and interpretations to illustrate the variability that arises in data interpretation and to discuss its implications.

Who Should Attend

Although the focus of the course is structural geology, the topics covered are essential to understanding the inter-dependency across Geophysics, Geology, Resevoir Engineering and the economics that underlies the decision making process throughout the petroleum exploration lifecycle.

The course is designed to be flexible around the experience of the participants and will be tailored to either entry level and intermediate level. It can also be delivered to include an advanced option.

Course Content

Topic 1 - Introduction

Session 1

- Introduction to geophysics principles
- Seismic interpretation fundamentals – what are you going to use the interpretation for?
- Structural geology fundamentals

Session 2

- Importance of understanding geo-history at basin, prospect and reservoir scale
- Identification of growth-stratigraphy and importance of pre, syn and post kinematic units
- Application of restorations to validate interpretation

Topic 2 – Extensional Systems

Session 3 – Normal Faults

- Recognising normal faults on seismic sections
- Identification of isolated normal faults and linked fault arrays
- Impact of fault identification and mapping on reservoir understanding

Session 4 – Normal faults and rift basins

- Linked arrays, additional fault complexity on mature fault systems
- Hydrocarbon plays on rift basins

Topic 3 – Compressional Systems

Session 5 -Reverse Faults

- Awareness of the variety of compressional structures that occur
- Development of the key structural styles of reverse faults and the associated folding
- Consideration of the limitations of seismic imaging for reverse faults

Session 6 – Interaction of reverse faults and 3D geometry

- Consideration of the lateral and temporal variation of reverse structures
- Impact on reservoir distribution and presence

Topic 4 – Complex, Multi-Phase Deformation

Session 7 – Strike-slip deformation

- Recognising strike slip deformation on seismic sections
- 3D and 4D evolution of strike-slip systems and impact on basin fill

Session 8 – Inversion tectonics

- Identification of both negative and positive structural inversion
- Impact on hydrocarbon systems and basin fill

Topic 5 – Other Settings

Session 9 – Salt tectonics

- This session will cover some of the key structural elements associated with salt basins.

Session 10 – Summary

- This session is flexible and can contain elements of the following:
  - Review and address any specific questions or exercises from the week that requires additional time
  - Discussion of how structural styles have to be considered as linked system in some examples such as margin collapse systems.

Other modules

In addition to the outlined elements, addition components can be included: fault seal, triangle diagrams, restorations, and passive margin/geodynamics.