N004: The Essentials of Rock Physics and Seismic Amplitude Interpretation

Instructor(s): Rob Simm or Eleanor Oldham

Format and Duration

Classroom - 4 Days
Virtual - 8 Sessions

Summary

This course presents the physical basis for quantitative seismic interpretation within the context of hydrocarbon exploration and production. Key technologies are explained in a straightforward manner; with topics including rock physics analysis of log data, well ties, 1D and 2D seismic modelling, amplitude and AVO analysis, seismic inversion to rock properties and the use of seismic amplitude information in prospect risking. Practical exercises utilise Excel based applets to aid understanding and the lessons learnt are of general application.

Business Impact: Rock physics has numerous applications for adding reserves and growing production within the business cycle; from recognition of diagnostic seismic signatures in prospect identification to reservoir characterisation and volumetric uncertainty estimation in field evaluation as well as enhanced oil recovery through time lapse techniques in field development. Moreover, a cross discipline understanding of rock physics is central to the effective integration of geology, petrophysics, geophysics, engineering.

Learning Outcomes

Participants will learn to:

1. Make a basic AVO model and use it to determine expectations in seismic interpretation in a variety of AVO scenarios.
2. Understand the principal characteristics of seismic wavelets and appreciate how the interference phenomenon can be used in the thickness prediction problem.
3. Tie a well using the well seismic matching and adaptive techniques and appreciate the importance of well tie information in the construction of forward models and seismic inversions.
4. Understand Gassmann fluid substitution and how rock physics models in general can be used in log conditioning and interpretation.
5. Understand different approaches to AVO analysis, how AVO projections work and the importance of data quality in the successful application of AVO analysis.
6. Understand bandlimited impedance and how it can be used in an AVO context for interpretation of net pay thickness.
7. Appreciate the differences between classical 'best estimate' seismic inversion and modern rock physics based techniques such as JiFi and ODiSI.
8. Understand the basics of Bayes theorem and how it can be applied in probabilistic approaches to seismic inversion and prospect risking.

Training Method

This is a classroom or virtual classroom course comprising a mixture of lectures, discussion, case studies, and practical exercises.

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Who Should Attend

The course is designed to be an introduction to practical rock physics application in seismic interpretation and would be of interest to all working Geoscientists, Petrophysicists, and Reservoir Engineers. For experienced Geophysicists who are regularly involved in seismic modelling, the course can be used as a refresher.

Course Content

Course content is evenly split between lectures that review the basics of how seismic relates to rock properties and PC-based practicals utilizing real data. Through the use of commercially available PC-based software, the basics of rock physics interpretation of seismic data are understood. By the end of the course, students will not only be able to create first order reflectivity models and understand the basics behind the buzzwords (AVO, EI etc), but also be able to ask pertinent questions that relate to the use of seismic data in prospect risking.

Lecture review topics include:

- Basic rock properties and reflectivity
- The mechanics of seismic data processing (Geometry, Stacking and Migration)
- An introduction to key processing issues
- Seismic bandwidth and the convolutional model
- Wavelets – shape, phase and polarity
- Resolution and non-uniqueness
- Fit and accuracy in seismic well ties
- Rock physics - where to get the numbers for modelling
- 1D and 2D seismic modelling
- AVO Analysis in reflectivity and impedance domains
- Seismic inversion to impedance, facies and rock properties
- Seismic amplitudes and the risking problem

Practical exercises include:

- Creating models of various AVO scenarios
- Net thickness prediction in thin beds
- Well tie using RokDoc (White and Adaptive methods)
- Fluid substitution on logs and AVO modelling
- Appreciating the amplitude scaling problem
- Understanding AVO projections
- AVO in the impedance domain
- Reflectivity and bandlimited impedance
- Simple net pay analysis
- The low frequency problem in inversion
- The role of the AVO gradient in determining Vs from P-wave seismic

- Risking case study