The Essentials of Rock Physics and Seismic Amplitude Interpretation (G075)

Tutor(s)

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Overview

This course introduces participants to the principles, workflows and limitations of interpreting seismic data using rock physics. The principal topics to be covered include how AVO works, what should the interpreter expect, rock physics inputs for seismic models, rock properties from seismic and rock physics in prospect risking.

Duration and Logistics

Classroom version: A 4-day in-person course, comprising a mix of lectures and interactive learning through worked Excel examples. The course manual will be provided in digital format.

Virtual version: Eight 3-hour live online sessions presented over 8 days, comprising a mix of lectures and interactive learning through worked Excel examples. The course manual will be provided in digital format.

Level and Audience

Fundamental. The course is largely aimed at geoscientists, reservoir engineers and petrophysicists wanting an introduction to the subject of rock physics and seismic amplitude interpretation.

Objectives

You will learn to:

- Construct a simple AVO model and apply it to seismic interpretation in different AVO settings.
- Illustrate the characteristics of seismic wavelets and approaches to synthetic well ties with reference to models.
- Demonstrate the use of rock physics for seismic modelling and Gassmann's equation in fluid substitution.
- Tackle a variety of rock physics issues, including fluid substitution in shaly and laminated sands, modelling of tight sands and log editing.
- Differentiate AVO techniques and practical AVO issues, including the potential for interpretation ambiguity and data quality.
- Apply band limited impedance with respect to net pay prediction and their limitations.
- Implement the use of Bayesian update to evaluate probability in inversion and risking.

Course Content

Session 1: Introducing seismic modelling, rock properties and AVO

- Seismic basics
- How amplitude vs offset (AVO) works
- A siliciclastic case study (variation of reflectivity style with depth; lithology and fluid trends on the AVO crossplot)

Session 2: Interpretation scenarios – What should the interpreter expect?

- An overview of AVO scenarios
- Case study examples, including Class II/III high porosity failure example, Class IV overpressure example, Class IIp oil sand, layering and variable lithofacies effects
- Fluid contacts
- DHIs
- Resolution and the problem of thickness prediction in thin beds

Session 3: Wavelets and well ties

- Characteristics of seismic wavelets
- Sonic log calibration
- Two approaches to synthetic well ties… White’s well seismic matching method and the adaptive method
- Discussion of well tie issues, such as ‘stretch and squeeze’, positioning issues and stratigraphic filtering
- Visual perception of phase
- Model issues – a VTI example
- Broadband wavelets

Session 4: Rock physics inputs for seismic models

- Overview of rock physics for seismic modelling
- Data sources
- Gassmann’s equation and fluid substitution – a worked example

Session 5: Rock physics issues

- Low saturation gas
- Fluid substitution in shaly and laminated sands
- Modelling of tight sands and multi-pore carbonates
- Log editing
- Rock characterization

Session 6: AVO analysis

- Overview of AVO techniques
- Coordinate rotations for lithology and fluid discrimination
- Reflectivity vs impedance
- Practical AVO issues...the noise prone gradient
- Offset dependent tuning
- Lithofacies variation and the potential for interpretation ambiguity
- The key issue of data quality
- Discussion of post-processing data conditioning

Session 7: Rock properties from seismic

- Bandlimited impedance
- Simple approaches to net pay prediction and their limitations
- Calibration and probability issues in the application of seismic attributes
- The nature of seismic trace inversion
- Classical (‘best estimate’) inversion approaches and their limitations

Session 8: Probabilistic inversion and rock physics in risking

- Introducing the use of the Bayesian update to evaluate probability in inversion
- Rock-physics-based approaches to inversion – JiFi and ODiSl
- Bayesian update methods in the risking context