# D004: The Essentials of Rock Physics and Seismic Amplitude Interpretation *(Distance Learning)*

Tutor(s): Rob Simm

| 4 Days | Competence Level: Foundation |
|---|---|
| Virtual Course | |
| Computer Usage | |

## Summary

**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.

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.

## Learning Outcomes

Participants will learn:

1. How to make a basic AVO model and use it to determine expectations in seismic interpretation.
2. To understand the different types of AVO scenarios.
3. To understand wavelet characteristics (amplitude and phase).
4. To understand the thickness prediction problem (for isolated layer scenarios) and the basis for simple net measures.
5. How to tie a well using the well seismic matching and adaptive techniques (RokDoc).
6. To appreciate how well ties provide valuable information on scaling the model to the seismic.
7. To understand the inputs to Gassmann's equation.
8. To appreciate the various conditioning aspects of logs.
9. How to perform fluid substitution on logs using Gassmann's equation.
10. Appreciate the use of 2D modelling as an aid to understanding seismic signatures.
11. Appreciate the role of different types of rock physics models and the issues in practical application.
12. Understand different approaches to AVO analysis and how AVO projections work.
13. Appreciate data quality issues in AVO.
14. Understand AVO in terms of impedance and reflectivity, and how this relates to angle independent rock properties.
15. Understand bandlimited impedance and how it can be used.
16. Understand different approaches to seismic inversion and the role of the 'prior'.
17. Appreciate the role of the gradient in the determination of Vp/Vs from seismic inversion.
18. Appreciate the various factors in simultaneous inversion introduce errors and bias.
19. Appreciate the need for stochastic solutions owing to non-uniqueness.
20. Appreciate the role of amplitude observations in prospect risking.

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## Duration and Training Method

A virtual classroom course divided into 8 three-hour long webinar sessions over a two-week period (equivalent to a four-day classroom) comprising a mixture of lectures, discussions, case studies, and worked examples to be completed by participants during and between webinar sessions.

## 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 including Geologists, Geophysicists, Petrophysicists, as well as Reservoir Engineers. For experienced Geophysicists who are regularly involved in seismic modelling the course can be used as a refresher.

## Prerequisites and Linking Courses

N004, along with N049 (Seismic Attributes for Exploration and Reservoir Characterisation) and N385 (Workflows for Seismic Reservoir Characterisation), is a cornerstone of the Reservoir Characterisation set of courses within the Geophysical Competency suite. It is suitable for non-geophysicists but requires a basic understanding of the seismic method such as that provided by N085 (Introduction to Seismic Interpretation) or N080 (Geophysics for Subsurface Professionals).

## Course Content

Course content comprises lectures and case study presentations that review the basics of how seismic relates to rock properties and PC-based practicals utilizing real data. Through the use of standard Microsoft Excel spreadsheets the basics of rock physics interpretation of seismic data are understood. By the end of the course, attendees 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

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Practical exercises include:

- AVO scenario modelling
- Net thickness prediction in thin beds
- Fluid substitution on logs and AVO modelling
- Modelling porosity change
- Appreciating the amplitude scaling problem
- Understanding AVO projections and AVO Interpretation
- Low frequency and AVO gradient issues in Inversion
- Risking case study