N080: Geophysics for Subsurface Professionals

Tutor(s): Steve Western / John Randolph

4 Days	Competence Level: Basic Application
Classroom Course	
Computer Usage	

Summary

This multidiscipline course will provide geoscientists and engineers with a practical understanding of what the seismic method can provide to impact business decisions. Specifically, we present how the seismic method is used to evaluate geologic risk, characterize reservoirs properties, estimate resource potential, optimize drilling locations and avoid drilling hazards. The course also provides an appreciation of the strengths and weaknesses of key seismic methods such as migration and inversion. Additionally, you will know what questions to ask about structural imaging and depth maps, seismic prediction of reservoir properties such as lithology, porosity, fluid type, thickness and fractures as well as pressure prediction. You will also learn a practical workflow for interpreting 3D seismic.

Learning Outcomes

Participants will learn to:

1. Describe the fundamentals of seismic propagation using wavefronts or raypaths, as appropriate.
2. Identify the various types of seismic waves and their relevance to different scenarios.
3. Appreciate the importance of rock parameters, especially velocity and density, in understanding the results of the seismic method.
4. Describe the fundamentals of surface and borehole seismic acquisition and processing, sonic logs and microseismic.
5. Appreciate the difference between the time and depth domains and how to convert between them.
6. Recognise the importance of resolution and how to maximise it.
7. Appreciate how seismic data is affected by rock properties such as porosity, lithology, fluid content, fractures and pressure and how seismic can be used to predict these parameters.
8. Recognise how it is possible to estimate reservoir properties from seismic data using AVO and inversion techniques integrated with petrophysical data.
9. Review how seismic anisotropy is used to predict fracture density and orientation, anticipate drilling hazards and optimize well locations.
10. Learn how to calculate various types of subsurface pressure and use pressure prediction to design wells, avoid drilling hazards and optimize reservoir production.
11. Recognize the power of multi-component seismic to distinguish reservoir lithology changes from fluid changes.
12. Apply a 3D seismic interpretation workflow to a large survey over the Gippsland Basin, offshore Australia. Hands-on interpretation of a regional seismic grid serves to reaffirm key interpretation concepts.

Duration and Training Method

The course will run for 4 days and include classroom instruction, worked examples, exercises and discussion.

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Who Should Attend

This course is designed for geoscientists, petrophysicists and engineers involved in multidiscipline teams using geophysical techniques as well as individuals responsible for managing or supervising exploration or asset teams.

Prerequisites and Linking Courses

There are no prerequisite courses but participants should have a general understanding of the exploration process and be prepared for some technical discussion.

Recommended geophysical courses that build on N080 include N004 (Essentials of Rock Physics and Seismic Amplitude Interpretation) and N049 (Seismic Attributes for Exploration and Reservoir Characterisation). Participants interested in seismic interpretation should consider courses N085 (Introduction to Seismic Interpretation) and N040 (Interpretation of Three-Dimensional Seismic Data).

Course Content

Preface: comparison of seismic workflows for conventional and unconventional plays

Introduction

- Basic concepts – types of sources, types of waves – surface, body, P, S
- Wavefronts vs. raypaths
- Velocity and density, acoustic impedance
- Reflections, reflection coefficient, depth to time conversion
- Shot gathers, single fold, multiple fold
- Stacking and zero-offset concept
- 2D geometry and coverage

Structural imaging

- Modelling – normal incidence, vertical incidence
- Principles of 2D marine and land acquisition
- 2D processing – statics, velocity analysis, NMO, stack
- Time migration, migration velocity, diffractions
- Simple depth conversion, average and interval velocity

Borehole geophysics

- Sonic logging - conventional and dipole
- Check Shots
- VSPs - Vertical, Walkabove, Offset, Walkaway
- Cross-well seismic

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Calibrated reservoir mapping

- Wavelets, frequency domain, phase
- Calibration to wells
- Vertical resolution, wedge model, tuning
- Horizontal resolution, diffractions, aperture
- Synthetic seismograms
- Amplitude mapping for sand thickness
- Porosity prediction and mapping

3D seismic imaging

- 3D land and marine acquisition
- 3D binning, processing and time migration
- Image ray tracing, depth migration
- Complex depth conversion and map migration

Lithology, porosity and fluid prediction

- P and S waves, earth parameters, moduli, Poisson's ratio
- Fluid substitution
- AVO modelling and analysis – reconnaissance and detailed
- Inversion for acoustic and elastic impedance and Poisson's ratio

Fracture detection and anisotropy

- Anisotropy – azimuthal, VTI
- Fracture detection and mapping
- Effect on velocities and AVO

Pressure prediction

- Causes of overpressure, shale porosity, equivalent depth, Eaton method
- Prediction from sonic log
- Prediction from seismic velocities

Time lapse (4D) seismic

- Basic concepts
- Data acquisition and processing
- Case studies

Multicomponent seismic

- Data acquisition and processing

- Case studies

3D Seismic interpretation workflow

- Gippsland basin 3D, offshore Australia