N629: Geophysics for Geologists and Petroleum Engineers

Instructor(s): Easton Wren

3 Days	Competence Level: Awareness
Classroom Course	

Summary

In modern exploration for oil and gas, geophysics is a key to success, particularly in offshore and frontier areas. Contemporary geophysics (seismic) provides the necessary technology to remote-sense the target to reduce the exploration drilling risk. Seismic also plays a significant role in reservoir characterization and development.

Geologists and Engineers have learned to visualize and quantify rock properties from their physical properties graphically represented in well logs. The challenge is to become equally comfortable with seismic data. The seismic trace can be considered as an additional log which, on the one hand comes by the thousand, yet on the other, does not have the resolving power of the sonic or density log.

This three-day course presents the basic geophysical principles in a non-mathematical yet practical, tutorial fashion with numerous exercises. The course will cover data acquisition, processing and interpretation. Non-mathematical in its treatment of seismic fundamentals it will inspire understanding and confidence in both disciplines wanting to learn the basics, the limits, the pitfalls and the benefits of modern seismic techniques. Interpretation of seismic data is a key component of the course. Both 2D and 3D seismic will be explained as well as techniques in resolution, structural imaging, AVO and attribute analysis.

Learning Outcomes

Participants will learn to

- Understand seismic fundamentals and the advantages of seismic data in their exploration and exploitation practice.
- Interpret seismic sections
- Recognise the pitfalls intrinsic in seismic data
- Visualize the geology in seismic data the way they visualize geology in logs.
- Participate in a drilling game using seismic to determine locations
- Understand the terminology to be able to communicate intelligently with their geophysicist colleagues

Duration and Training Method

Three classroom days providing 2.4 CEU (Continuing Education Credits) or 24 PDH (Professional Development Hours)

Who Should Attend

Petroleum Geologists, Engineers and Junior Geophysicists of any length of experience will find this course of significant benefit in understanding seismic fundamentals and will learn the advantages of seismic data in exploration and reservoir characterization.

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Course Content

Course Agenda

Day One

1. Themes: Summary of the key topics
2. Closed Loop: where seismic fits in the exploration process
3. Leonardo Da Vinci's Contribution: optics and acoustics
4. Reflection Coefficient: R = (D2V2 – D1V1)/ (D2V2 + D1V1) at a geological boundary
5. Polarity convention of well logs and seismic data
6. Anatomy of a Seismic Section Display (S/N, resolution, scales)
7. In and out of the plane: 2D and 3D
8. Waves and Earthquakes P- and S-waves : Poisson's Ratio
9. Major Signal Attributes: Amplitude, Frequency, Phase
10. Windows Media Player: time and frequency analysis of Mozart & Rock'n Roll
11. Convolution: making simple seismic traces by hand from simple well logs
12. Gold Creek gas field seismic model
13. Seismic and the Sonic Log; the mathematical relationship
14. Structural Modeling: Step and V-shaped models; effect of dip and velocity; pull-up & migration
15. Seismic Interpretation 101: Hibernia, Jumping Pound. Fairview. Real data example exercises
16. Drilling Game:

Day Two

1. Stratigraphic Modeling: Synthetic Seismogram
2. GeoSyn Synthetic Seismogram software demo
3. Choice of wavelet (Ricker, Ormsby), polarity, stretch (Q), calibration
4. Resolution: Definition of Tuning, detection, amplitude mapping

   $Z = V/2.8f$
5. The Landman Story of Resolution
6. Drilling Game:
7. Acquisition: early history, channels, fold, signal, noise, geophones, dynamite, vibroseis, marine
8. Borehole Geophysics: checkshot, VSP, Tomography, Microseismic
9. 3D Seismic; definition, benefit, pitfalls, 4D, 5D
10. Seismic Data Processing: Menu, key steps, Deconvolution, Statics, stacking, pre-stack and post-stack migration
11. Rubik Cube: a perfect analog to 3D seismic
12. Workshop Exercises

Day Three

1. Seismic Interpretation: Basic fundamentals, non uniqueness, learn by experience
2. Key topics: structural examples, channels, reefs, exercises
3. Seismic Signal Amplitude: "bright Spots" and "DHI's), history, examples
4. Factors affecting amplitude
5. Seismic Inversion: theory and examples
6. The pre- and post- stack domains
7. Amplitude versus Offset (AVO); basic theory and history

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8. Classical Equations: Knott Zoeppritz and the Dipole Sonic Log
9. Rock Properties and Poisson's Ratio: Petrophysics
10. Otto Koefoed and the origins of AVO
11. The offset synthetic seismogram
12. The Shuey Approximation to simple AVO modeling
13. AVO in sandstones: signatures and examples
14. AVO in carbonates: signatures and examples
15. AVO Inversion and Cross-Plotting
16. Seismic Attributes: Definition and partial listing
17. Historical evolution of the focus on attributes
18. The Hilbert Transform and Instantaneous amplitude, frequency and phase
19. Curvature, coherency and spectral decomposition