Multi-Component Seismic and Anisotropy

Course Price

£2750

Course Description

Conventional seismic data (marine data and vertical geophones for land data) is dominated by P-waves. With the tendency to employ larger spreads also a larger contribution of S-waves will be recorded. However, it is with the use of multi-component seismic, preferably with a multi-component source as well as multi-component receiver, that the full (vector-)wavefield will be recorded. Such datasets can then be used to extract the P-wave and S-wave characteristics.

This requires special multi-component data processing techniques. In addition, as S-waves are more sensitive to anisotropy than P-waves and moreover display the unique feature of shear-wave birefringence (shear-wave splitting), it is necessary to take anisotropy into account in the processing. Such anisotropy can then be related to its causes and allow the derivation of e.g. fracture orientation and fracture density. As a marine environment does not support S-waves, the only way to record S-waves in such an environment is with ocean bottom cables and ocean bottom systems, where use is made of the generation of reflected S-wave energy at the reflectors from incident P-waves. Multi-component data acquisition and the various ways of multi-component data processing will be treated and a full understanding of anisotropy will be provided.

A case study with acquisition and processing of a real 3D nine-component seismic survey combines all aspects of multi-component seismic and anisotropy and concludes this course.

Course Objectives

Participants will understand anisotropy and be able to assess its consequences for seismic data processing and be able to extract the relevant anisotropy parameters and use these for subsequent interpretation. They will be able to apply the commonly used multi-component processing methods and produce in the end the PP, PS, SP and SS datasets together with the characteristics of each of these for subsequent interpretation.

Participants can provide the geophysical input that is required in a multi-disciplinary team that is considering a multi-component seismic survey.

Who Should Attend
This course is designed for those geophysicists who want to extract the most from seismic data, i.e. it deals with full elastic data acquisition and subsequent processing including a correct handling of anisotropy. All relevant theoretical and technical aspects will be treated as well as practicalities together with the discussion of several case studies.

Course Content

Anisotropy
1. Introduction and definition of anisotropy
2. The stress tensor, the Voigt form and symmetries
3. Plane wave solutions and Christoffel equations
4. Phase velocity and Group velocity
5. Relationships between Wave surface and Slowness surface
6. Measurement of group velocity and phase velocity
7. Raytracing, eiconal equation and transport equation
8. Shear wave splitting
9. Definitions pertaining to anisotropy
10. Transverse isotropy (TI):
    – Angle dependence of velocities in VTI media
    – Thomsen’s notation for weakly anisotropic media
    – Elastic constants in finely layered media
    – Reflection and Transmission coefficients
    – HTI media
11. Anisotropy from seismic measurements – processing
12. Crack and fracture properties

Multi-component seismic, shear seismic and anisotropy
1. The data matrix

2. Polarization analysis of three component seismic
3. Polarization filtering

4. Rotation of sources and receivers

5. Characteristics of P-, SV- and SH waves

6. Converted waves: generation and processing

7. Displacement components of free surface geophones

8. The wavefield generated by a vertical vibrator

9. P/S-wavefield separation:
   – Surface data
   – VSP data

10. Elastic wavefield decomposition

11. Elastic migration and redatuming

OBC (ocean bottom cable) and OBS (ocean bottom system) seismic

1. OBS and OBC features

2. Processing
   – hydrophone and vertical geophone
   – hydrophone and vertical and radial geophone
   – vertical and radial geophone
   – hydrophone and three-component geophone
   – source signal estimation from dual conjugate field measurements

3. Acquisition
   – receiver location determination
   – calibration

4. Case studies

Case Study

Acquisition and processing of a real 3D nine-component survey.
CPD Unit

Continuing Professional Development

21 HOURS CPD