N217: Seismic Imaging and Velocity Model-Building Techniques: Concepts, Examples and Pitfalls

Tutor(s): Etienne Robein

4 Days	Competence Level: Skilled Application
Classroom Course	

Summary

This is an advanced course beginning with the theoretical basis of the seismic reflection image and working through a systematic description of the principal techniques deployed by today's seismic processors to image complex subsurface structures in time or depth domains. This course will allow participants to evaluate the potential value of competing techniques and gain a greater understanding of the issues in complex velocity model building.

Learning Outcomes

Participants will learn to:

1. Understanding the nature of what constitutes the reflection seismic image.
2. Foundations: wave equation, propagation velocity, seismic anisotropy, wavefield and rays, sorting data for imaging and wavefield seperation.
3. Ray-based depth migrations: the Kirchhoff method versus the various Beam techniques.
4. The assumptions, benefits and limitations of Pre-stack Time Kirchhoff migration.
5. Wavefield Extrapolation based migrations (WEM and RTM): the benefits and issues associated with each imaging method.
6. How do we go about the building of complex velocity models? Ray-based linear and non-linear tomography and WE-based methods. Assessment of anisotropic parameters with borehole control and uncertainties.
7. The principles and potential of Full Waveform Inversion illustrated by examples in various contexts.
8. Importance of acquisition style, multi- and especially wide azimuth.
9. The intrinsic link between the depth imaging process and the interpreter in the workflow.

Duration and Training Method

A four-day classroom course comprising a mixture of lectures, case studies and classroom exercises.

Who Should Attend

Those geoscientists either working with, or supervising, projects involving complex subsurface velocity model-building and imaging challenges.

Prerequisites and Linking Courses

It is strongly recommended attending N317 before attending this course to acquire an adequate grounding in seismic processing and interpretation. Other courses to consider on this basis would be N085 (Introduction to Seismic Interpretation) or M080 (Geophysics for Subsurface Professionals).

This course will be closely allied to our two depth conversion courses, N002 (Velocities for Depth Conversion) which would be an extremely useful primer, discussing the fundamentals of velocities and their application to depth conversion; and N172 (Depth Conversion: Methods and Pitfalls), which tackles the standard depth conversion techniques based on average and interval velocities and how the velocity model building process takes place from a geologist's perspective.

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Course Content

Imaging of seismic data in both time and depth will be explained, with their disparity in accuracy, but commensurate difference in time and effort required. This is because time-imaging encapsulates its velocity analysis, albeit with an associated reduction in quality, while depth-imaging involves explicit velocity model definition and includes time-to-depth conversion.

Through technological advances in acquisition, imaging and computing, we are now increasingly able, to correctly depict complex subsurface scenarios and image structures previously invisible. Throughout the course, the interaction between the imaging process and the art (and science) of the interpreter will be emphasised.

- Understanding the nature of what constitutes the reflection seismic "image"
- Overview of current Pre-stack Depth imaging techniques; Ray-, Beam- and Wavefield Extrapolation-based methods
- The specific case of Pre-stack Time Migration
- The benefits and issues associated with each imaging method
- The key imaging parameters that drive success in the imaging process
- Deliverables.
- Importance of acquisition style in imaging, especially wide-azimuth shooting
- How do we go about the building of complex velocity models? Various tools and workflows
- Borehole control for the estimation of anisotropic parameters (epsilon and delta fields)
- The potential of Full Wavefield Inversion
- Recent developments in depth imaging: wavefield separation; least squares migration; imaging with surface-related multiples; assessment of uncertainties
- The intrinsic link between the imaging process and the interpreter in the modern workflow