Lecture 1. From Time to Depth: Using seismic data for depth modelling and imaging

Depth Imaging uses processed seismic data to estimate models and images of the subsurface with their features correctly positioned in depth. Depth models describe the seismic properties of the subsurface, allowing us to map the non-linear relationship between the structure of physical features generating seismic reflections, and the seismic data recorded at the surface. Depth Migration uses these models to produce an image by correctly repositioning the recorded seismic data. Tomography and Full Waveform Inversion are the key methods used to obtain these models.

This lecture introduces the mathematical background to these techniques, focusing on the various physical simulations involved (forward problems) and the techniques used to obtain models of the subsurface from the data (inverse problems).

Lecture 2. High-Fidelity Imaging: Pushing the boundaries of resolution and accuracy

Significant recent advances in high-fidelity seismic imaging have come from wave equation methods (Full Waveform Inversion and Reverse Time Migration), and the characterisation of seismic anisotropy (the directional dependence of seismic wave propagation). Waveform methods have led to a dramatic increase in imaging resolution; improved characterisation of anisotropy has improved focus and the accuracy of feature positioning in depth. These advances were possible because of the availability of large-scale, low-cost graphics processing unit (GPU) clusters.

This lecture introduces the Full Waveform Inversion (FWI) method, covering its origins, the principal FWI variations, and practical application to complex, anisotropic velocity models, with some final comments on future directions.