

Imaging the Invisible: Seismic Tomography Reveals Earth's Hidden Structure and Dynamics

F. Rappisi¹

¹European Center for Geodynamics and Seismology, L-7256, Walferdange, Luxembourg

Corresponding author: francesco.rappisi@ecgs.lu

Abstract:

Understanding how the Earth deforms and evolves requires looking beneath its surface — into regions that cannot be observed directly. Seismic tomography offers this unique window, transforming seismic waves into three-dimensional images of the subsurface. Beyond mapping variations in seismic velocity, recent advances allow us to detect anisotropy — directional dependence of wave speed — which encodes information about rock fabric, deformation, and stress. Here, we introduce the fundamental concepts of seismic tomography and anisotropy. We highlight how these methods reveal both the structure and the dynamics of the lithosphere and upper mantle. Using examples from regional to local scales — from active convergent margins to volcanic environments — we show how tomographic models illuminate the processes shaping our planet's interior. By integrating seismic imaging with other geological and geophysical observations, we can bridge deep and shallow processes, linking subsurface dynamics to the observable evolution of the Earth. Seismic tomography thus emerges not only as a tool for imaging structure, but also as a way to visualize the living dynamics of the Earth.