Regional and global seismic tomography: Imaging the structure and dynamics of the Earth

The rapid recent expansion of seismic networks around the world has paved the way for a new generation of tomographic models, with significantly improved resolution at both regional and global scales. In order to take advantage of the extraordinary volume of new data, new processing and inversion methods are being developed, taking into account complexities of seismic wave propagation and aiming to extract abundant, accurate structural information from each seismogram. The resulting new models reveal seismic-velocity structure and anisotropy of the crust and mantle in unprecedented detail. Interpreted together with other geophysical and geological evidence, they bring important new discoveries on the structure and dynamics of the Earth.

At global scale, multi-mode waveform tomography provides increasingly detailed images of the lithosphere, deep upper mantle and transition zone. Our group's new waveform data set is derived from over one million seismograms. It constrains layered structure and anisotropy of the crust and upper mantle globally, but with resolution at the fine, regional scale of tectonic units. This unique data set also offers new insight into the bulk multimode-dispersion properties and heterogeneity of the Earth and into the global wave propagation and the validity of surface-wave ray theory.

At regional scale, new broadband-array methods provide particularly high resolution of seismic structure, anisotropy and, by inference, deformation of the crust and mantle. Our recent results reveal previously unknown mechanisms of complex lithospheric deformation in the Eastern Mediterranean and in Tibet. In Ireland, rapid progress of broadband seismology (in particular, the emergence of Ireland Array) has stimulated new research of immediate societal importance, including applications to geothermal resource assessment.