Attenuation structure beneath Australia

Agus Abdulah

Australian National University

Abstract

The strategic position of the Australian continent in the middle of seismicity belts which extend from Java to Sumatra and the mid-ocean ridge to the south of the continent provides a wealth of events at suitable distances to be used as probes into the seismic structure of the upper mantle. The extensive deployment of portable broadband seismic stations across the Australian continent and Tasmania since 1993 offers robust seismological data with a dense coverage at distances from 5° to 45°. Over the last two decades, a wide range of studies have been used to gain information on one-dimensional and three-dimensional structure in the mantle which exploits different aspects of seismograms. P and S wave seismic travel times from nearly 4000 three-component seismic datasets from the record have been hand picked. The wave ratio method is then applied to estimate the spectral ratio between shear and compressional waves. Seismic spectra are estimated using the multi-taper method with 512 points in a window range of 30s to 45s and a frequency range of 0.25Hz to 1.00Hz.

Three-dimensional P and S wave speed tomography is conducted by inverting a kernel matrix obtained from a quasi three-dimensional ray tracing which respect to P and S wave seismic travel-time residuals from the ak135 model. The study area from latitude 22° N to 65°S and longitude 78° to 189° and 0-1240km depth is discretised into 11100 cells with a cell size of 3°x3° and depth increments of 35 or 200km. Both P and S-wave speed information from the seismic wave speed tomography are then utilised as data input for 3-D seismic attenuation tomography. In this inversion, it is assumed that $Q_P=2.3Q_S$. The seismic attenuation anisotropy in terms of the ratio between seismic attenuation derived from SV and SH component is also presented.

The major feature that is revealed from both the seismic wave and seismic attenuation studies is a strong contrast in deep structure between central Australia and the eastern seaboard (as can be seen in the figure). Further representation of seismic attenuation anisotropy suggests that in the region where seismic coverage is good, the transverse component (S_H) wave is less attenuated than the radial component (S_V). Archaean and Proterozoic rocks in the west and in the middle of the continent point to a high seismic wave speed anomaly and low seismic attenuation, and the Phanerozoic rocks and the presence of recent volcanism and region of high heat flow in the east are associated with low seismic wave speed anomaly and high seismic attenuation.