Seismological structure beneath southwest Japan and its tectonic and geodynamic implications

Mohamed Salah[1], Dapeng Zhao[2]

[1] Earth Sci., Ehime Univ, [2] GRC, Ehime Univ

We have carried out a variety of seismological studies on the crust and upper mantle beneath the Southwest (SW) Japan. The structure of this region is relatively poorly studied seismologically compared to the Northeastern Japan. Spatial distribution of seismic velocity (Vp, Vs) and a few other geophysical parameters such as Poisson's ratio, crack density, saturation rate and porosity have been studied beneath Kii Peninsula. This area is located in the forearc region of SW Japan and has distinct structural and tectonic features characterized by high seismicity in the crust and the subducting Philippine Sea slab, high surface heat flow, high 3He/4He isotopic ratio, and a local change in the geometry of the subducting slab.

We have also adopted a new approach to detect and collect later phases associated with the Moho discontinuity and use them to study the lateral variations of the crustal thickness beneath Kii Peninsula and its surrounding areas. First, we compute synthetic seismograms for local crustal earthquakes taking into account the focal mechanism solutions estimated from first motion polarity data. Then, we compare the synthetics with the observed waveforms to identify the Moho reflected waves (PmP and SmS). Taking the advantage of the high quality and great quantity of Hi net waveform data available throughout the entire Japan Islands, we have detected 1659 Moho reflected phases from shallow events in SW Japan. The crustal thickness in this area is estimated by using travel time differences between these later phases and the first P and S arrivals.

Seismic attenuation (Q factor) that can be estimated by extracting the amplitude and frequency information contained in seismic waveforms, provides an important insight into the nature of heterogeneities in the Earth's structure and composition and can deepen our understanding of the heterogeneities and complexities revealed by travel time tomography and crustal thickness studies. Because only a few Q studies have been carried out in SW Japan, we have investigated the 3 D P wave attenuation structure of the crust and upper mantle beneath SW Japan using P wave spectra of microearthquakes recorded by the Hi net seismographic network. Spectra of a 2 s, cosine tapered time window, after the first P arrival were calculated for a total of 4105 high quality waveforms from 90 local earthquakes and inverted by using an inversion scheme to estimate the 3 D structure.

Travel time tomography results show significant heterogeneities in the crust and upper mantle wedge characterized by low seismic velocities, high Poisson's ratio, high values of crack density, saturation rate and porosity. These results suggest the existence of fluids in the crust and mantle wedge resulting from the dehydration of the subducting Philippine Sea slab. Crustal thickness results reveal, in accordance with the previous studies by other researchers, that the Moho is deep beneath the middle of the land area and becomes shallower toward the coasts of the surrounding seas. A thinner crust also appears beneath Osaka Bay and Awajii Island where the 1995 Kobe earthquake occurred. Low Q zones are detected under volcanic areas, while high Q zones in the uppermost mantle under Kii Peninsula and Shikoku show the image of the subducting Philippine Sea slab which is in good agreement with results revealed by travel time tomography.