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Three-dimensional attenuation structure beneath the Tokai region, central Japan

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Long term slow slip (LTSS) and non-volcanic low frequency earthquakes (LFEs) were reported in the central part of the Tokai district, central Japan. Such LTSS and LFE events are considered to take place at transition zone from stick-slip zone to stable sliding zone and to be associated with fluids on the subducting Philippine Sea plate's surface. To clarify the spatial variation of the physical properties in this region, we estimated a three dimensional seismic attenuation structure using joint inversion method.

In this study, we used 3688 spectra of 140 earthquakes which were observed by both temporary stations conducted from April to August in 2008 and permanent stations. Frequency band was divided equally among 24 between 0.78125 and 18.75 Hz and equally among 8 between 18.75 and 31.25 Hz. We gave Q blocks by dividing study area into 7 in the N-S direction between 137E and 138.5E degree, into 6 blocks in E-W direction between 34.5N and 35.7N, and 6 depth layers. We estimated frequency independent Q value of each block.

In the shallow depths from surface to 5km, we found a lower Q zone located along the Median tectonic line which divides the southwestern Japan into two parts; a old geologic belt and a new accretionary belt. In the lower crust of the land plate at the depths of 17 to 25km, a very high Q zone (about 2000) exists just above the region where large slip rate was observed in LTSS between 2001 and 2005. Since very few earthquakes occur in this high Q zone, that portion might consist of harder rocks than surroundings. On the contrary, the region just beneath the large slip zone has lower Q than surrounding area. Comparing our results with the seismic velocity structure derived from travel time tomography, we found the high Q zone approximately coincides with relatively high velocity zone, and lower Q zone corresponds to the relatively low velocity and high Vp/Vs region. As mentioned in previous studies, low Q zone with low velocity and high Vp/Vs is interpreted as the zone which involves high-pressure fluid. Probably the high Q zone above the large slip zone works as a cap rock and prevents the fluid moving toward the shallow part, then the fluid pressure becomes high and it affects the occurrence of slow slip in this region.

Keywords: attenuation structure, Q value, Tokai region, slow slip