Seismic attenuation and seismogenic layer in the crust beneath the Kyushu Island

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The spatial distribution of the seismogenic layer is one of the important parameter for seismic hazard analysis. The focal depths of inland seismicity are restricted to the upper several tens kilometers of the crust and are varied depending on the tectonic settings. Previous studies reported the negative correlation between the depth of the seismogenic layer and heat flow [e.g., Sibson, 1982; Ito, 1990; Tanaka and Ito, 2002]. Recently, increasing studies suggest that fluids play an important role in triggering earthquakes [e.g., Terakawa et al., 2010]. At present, it is widely believed that the spatial distribution of seismogenic layer is controlled by temperature and pore fluid pressure (and strain rate). However, quantitative estimates of the two parameters are difficult. Instead, in this study, we compare the spatial distribution of seismogenic layer and seismic wave attenuation, which is sensitive to temperature and existence of fluid. This is expected to provide us new insight into physical properties of the crust and control parameters of inland seismogenesis.

Attenuation of seismic wave energy is caused by two factors: scattering and intrinsic absorption. The former is the scattering of seismic wave energy due to random heterogeneities in seismic wave velocity and the density of the medium, while the latter is the conversion from seismic wave energy to heat energy by internal friction due to anelasticity of the medium. Quantifying scattering and intrinsic attenuation is important to understanding the structure of the lithosphere in terms of seismotectonic features. In this study, we separately estimate scattering and intrinsic attenuation by applying the multiple lapse time window analysis (MLTWA) technique [Hoshiba et al., 1991]. This technique is based on a comparison between observed and calculated seismic wave energy density obtained using radiative transfer theory in several successive lapse time windows.

Estimated structures of scattering and intrinsic attenuation in the crust beneath the Kyushu Island show strong spatial variations that depend mainly on the tectonic setting. The seismic attenuation structures are compared with local cut off depth of inland earthquakes, “D90” defined as the depth above which 90 % of the earthquakes occur [Matsumoto et al., 2015]. Regions with high attenuation geographically correlate with shallow seismogenic layers. We will discuss quantitative relation between intrinsic and scattering attenuations and local depths of seismogenic layers.

