

Crustal seismogenic layer beneath Japanese Islands estimated from high resolved hypocenter catalog and heat flux data

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The lower limit of seismogenic layer within the crust is important parameter for the earthquake hazard assessment. This is because it relates to the maximum size of earthquakes caused by the active fault. We investigated the indexes D90 and D95 as the lower limits of the seismogenic layer defined as the depth above which 90 % and 95 % of the whole crustal earthquakes occurred from the surface, respectively. We verified the seismogenic depth for particular earthquakes occurred after the year of 2001, such as the 2004 Chuetsu, 2007 Noto, 2007 Chuetsu-Oki, 2016 Tottori, and 2016 Kumamoto earthquakes. We then compared the isotherm where the temperature estimated to be 250, 300, and 450 degrees in Celsius.

We estimated D90 and D95 from two different earthquake catalogs. First, we used the 3D earthquake catalog including events location determined based on the 3D velocity structure (Matsubara and Obara, 2011). This 3D catalog was used particularly for getting the D90 value around the costal region. Second, we used the 3D catalog including 12 years between 2001 and 2012 from the NIED Hi net catalog (JUICE catalog, Yano et al. 2017) for high resolution hypocenter locations (Depth <40 km, M>0.0). This catalog was used to get D95 values. In order to satisfy Gutenberg-Richter magnitude-frequency relation, we chose events $M \geq 1.5$. We then calculated the D90 and D95 using the same method as Matsubara and Sato (2015) except D95 is calculated at smaller grid points than D90 to fit the resolution of its catalog. For isotherm, where the temperatures are 250, 300, and 450 degrees, were estimated from heat flux measured at Hi-net boreholes (Matsumoto, 2007) and other additional data Sakagawa et al. (2005). Depths were calculated using the steady-state, one-dimensional, heat conduction equation with an exponential decrease in the radioactivity heat generation introduced in Tanaka (2004).

The general pattern of our results is consistent with previous studies of D90 as very deep D95 beneath the northern Hokkaido and northern Honshu and very shallow D95 along the volcanic front. After looking at the regional pattern of seismogenic depth, we found that our D90 and D95 showed the deepest boundary of hypocenter of mainshock, majority of aftershocks, main co-seismic slip regions for many large events except the aftershocks of the 2016 Kumamoto Earthquake. We concluded that the deep aftershocks of the Kumamoto event occurred within the brittle-ductile transition zoon from our limited evidences, such as the aftershocks region has too high P-wave velocity as 7.4 km/s for crustal brittle layer and the temperature is higher than 300 degrees.

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