# Revisiting the correlation among source regions of large earthquakes, thickness of seismogenic layer, and *b*-value of the Gutenberg-Richter relationship

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I estimate the shallower and deeper limits of seismogenic layer by using the Japan Unified hI-resolution relocated Catalog for Earthquakes (JUICE; Yano *et al.*, 2017), and correlate them with the geothermal parameters such as surface heat flow and thermal gradient of ground temperature. I then investigate the correlation among the seismogenic layer thickness, distribution of historical large earthquakes during the recent 100 years and the *b*-value of the Gutenberg-Richter (G-R) relationship.
I estimate D10, D50, and D90, i.e., 10%, 50%, and 90% of earthquakes occurred shallower than these depths, respectively in each mesh where the number of events is 20 or more. Because of a possible inclusion of low-frequency events and/or inter-plate earthquakes, D10, D50 and D90 may not necessarily represent the minimum, average and maximum depths of crustal shallow earthquakes; hence, I exclude meshes in which the average depth is deeper than 20 km, or meshes with the standard deviation in hypocenter depth of 6 km or more. The *b*-value of the Gutenberg-Richter relationship was estimated by the maximum likelihood estimate (Aki, 1965; Utsu, 1965, 1978) and their standard deviation was from the method by Shi and Bolt (1982).
The seismogenic layer is thick in the Niigata Prefecture, along the Itoigawa-Shizuoka tectonic line, Hiroshima Prefecture, and D10 and D90 become shallower toward Quaternary volcanoes. There is a clear negative correlation between upper and lower bounds of seismogenic layer and thermal parameters such as the thermal gradient or the crustal heat flow; the steeper thermal gradient or the higher crustal heat flow is, the shallower the upper and lower bounds of seismogenic layer become. These results suggest that seismogenic layer is strongly controlled by thermal structure of the upper crust as reported before. In perspective, spatial distribution of seismogenic layer thickness is consistent with our previous studies (e.g., Ishibe and Shimazaki, 2008), in which the unified Japan Meteorological Agency catalog during 9 years (October 1997 - October 2006) was used for analysis. Crustal large earthquakes during the recent 100 years seem to have occurred in the regions where the seismogenic layer is thick or seismogenic layer thickness steeply changes. The *b*-value of the G-R relationship systematically decreases as the thickness of seismogenic layer become thick, suggesting that the thickness of seismogenic layer plays an important role to constrain the extent of faulting rupture.
The thickness of seismogenic layer is one of the important parameters to characterize the size of earthquakes because it directly gives the limits of fault width in the region. Thus, the number of studies have estimated the spatial changes of the seismogenic layer and reported that these are closely correlated with the thermal structure of upper crust (e.g., Kobayashi, 1977; Ito, 1990). Moreover, It was reported that the distribution of historical crustal large earthquakes or Quaternary active faults well corresponds to the region where the deeper limit of crustal earthquakes or the thickness of the seismogenic layer steeply changes (Ito, 1999; Ochi and Zhao, 2001).
Acknowledgments: I used the Japan Unified hI-resolution relocated Catalog for Earthquakes (JUICE; Yano TE, Takeda T, Matsubara M, Shiomi K (2017). Japan Unified hIgh-resolution relocated catalog for earthquakes (JUICE): Crustal seismicity beneath the Japanese Islands. Tectonophysics 702:19-28. doi:10.1016/j.tecto.2017.02.017) provided by the National Research Institute for Earth Science and Disaster Resilience (NIED).

 

Keywords: thickness of seismogenic layer, b-value of the Gutenberg and Richter relationship, Japan Unified hI-resolution relocated Catalog for Earthquakes (JUICE)