Lower lomit of seismogenic zone beneath Japan based on hyopocenter catalog determined with 3D seismic velocity structure

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1. Introduction

Japanese Islands are under compressional stress owing to the subduction of the Pacific plate from the east. There are many active faults in and around the Japanese Islands. The lower limit of the seismogenic zone (D90) is important to estimate the maximum size of the earthquake with the active faults. We relocate hypocenters with three-dimensional (3D) seismic velocity structure (Matsubara et al., 2019) and estimate the lower limit of seismogenic zone for the crustal events beneath Japanese Islands.

2. Data and Method

We relocated 561,611 events from October 2000 to December 2017 within 129.2-146.3E, 30-46N, and 0-100 km depth with 3D seismic velocity structure (Matsubara et al., 2019). We selected events with depths of 0-25 km to be considered as those related to the active faults. We investigated the index D90 as the lower limits of the seismogenic layer defined as the depth above which 90 % of the whole crustal events occurred from the surface. The size of area in which we count earthquake is +/-0.1 degree in case of focusing the active faults and 0.25 degree in case of focusing the area.

3. Result

The shallow seismicity is low in the Hokkaido. D90 is shallow as 7-10 km at the central Hokkaido along the volcanic front. D90 beneath the southern Hokkaido is extremely deep as 20-25 km. D90 is extremely shallow around 7-10 km along the volcanic front however those along the coast of Sea of Japan and Pacific Ocean are deep as 16-20 km beneath the northeastern Japanese island arc. D90 is shallow as 9-12 km around Iwaki region activated after the Tohoku-oki Earthquake on March 11, 2011.

D90 beneath the central and Kinki region are approximately 15 km except the shallow 7-12 km D90 regions such as the volcanic chain, the Izu Peninsula, and the southern side of the Median Tectonic Line (MTL). D90 beneath the Kanto Mountains and Kiso and Akaishi Mountains are deeper than 20 km.

D90 on the side of the Sea of Japan beneath the Chugoku region are shallow however, the southern side are extremely deep. D90 on the southern side of the MTL is also shallow as 10 km beneath the Shikoku region.

D90 beneath the Kyushu region is 12-16 km except the volcanoes. D90 in the southeastern part on the PAC coastal region of Kyushu is 16-20 km shallower than the upper boundary of the PHS plate.

4. Discussion

Our result is roughly consistent with the results by Olmuralieva et al. (2012). Shallow D90 region is consistent with the high heat flow region (Matsumoto, 2007) such as volcanic zones and deep D90 region is consistent with the low heat flow such as southern Hokkaido, coastal region of the northeastern Japan, the Kanto region, southern Chugoku region, and southeastern Kyushu region. These are also consistent with the result by Olmuralieva et al. (2012).

Deep D90 regions are consistent with shallow Moho regions such as southeastern Hokkaido, eastern side of the Hidaka Mountains, coastal regions of northeastern Japan, northwestern Kanto region, southern Kii peninsula, and Seto Inland Sea region (Matsubara et al., 2017). The Sea of Japan coastal region of northeastern Japan and northwestern Kanto region are consistent with the failed rift formed at the Sea of Japan opening. Shallow D90 regions are consistent with deep Moho regions such as volcanic front beneath Hokkaido and northeastern Japan, and central mountainous region. eneath the mountainous region in the central Japan except the volcanoes is consistent with the deep Moho region.

5. Conclusion

We calculate the D90 as the lower limit of the crustal seismogenic zone beneath the Japanese Islands. The D90 beneath Japanese Islands is almost 12-16 km except the active volcanic zone and mountainous zone. D90 beneath the active volcanoes is shallower than 10 km, however, that beneath the mountaineous zone is deeper than 20 km. Deep D90 regions correspond to the high heat flow regions and shallow ones correspond to low heat flow regions.

Keywords: Seismogenic zone, Lower limit, Hypocenter catalog

