Temporal variation in coda Q in the central part of the Niigata-Kobe strain concentration zone

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In order to understand the stress accumulation process that causes inland earthquakes, the Niigata-Kobe strain concentration zone (NKTZ) (Sagiya et al., 2000), where the strain rate is about one order of magnitude higher than in the surrounding area, has been attracting attention. Iio et al. (2002) proposed a weak zone model, which suggests that the strain concentration zone is caused by the lower crustal viscosity and higher deformation rate than the surrounding area. Hiramatsu et al. (2013) studied the spatial distribution of coda Q in the central part of the NKTZ and found that the coda Q in the low-frequency band is an indicator of the deformation rate of the lower crust, suggesting that the high strain rate zone may be caused by the high deformation rate below the brittle-ductile transition zone of the crust.

On the other hand, Dojo and Hiramatsu (2017) pointed out that the deformation of the upper crust is dominant in the northeastern part of the NKTZ, suggesting that the cause of the strain concentration zone may differ between the central and northeastern parts of the zone. Stress/strain changes accompanied by large earthquakes/afterslips can modify the stress state in the crust, which is detected as a change in coda Q (Hiramatsu et al., 2000; Sugaya et al., 2009; Padhy et al., 2013). The 2011 off the Pacific coast of Tohoku earthquake caused a significant change in the displacement rate, mainly in the east-west direction, in northeast Japan. Dojo and Hiramatsu (2019) reported that there was no significant temporal variation in the spatial distribution of coda Q before and after the 2011 off the Pacific coast of Tohoku earthquake in the northeastern part of the NKTZ, suggesting that a localized and persistent ductile deformation in the crust is likely the main cause of the high strain rate zones in the NKTZ.

In this study, we investigate the temporal variation in coda Q before and after the 2011 off the Pacific coast of Tohoku earthquake in the central part of the NKTZ, and discuss the formation of the strain concentration zone in the central part of the NKTZ. We analyzed waveform data from March 2008 to February 2011 and from January 2012 to December 2015 recorded by Hi-net of the National Research Institute for Earth Science and Disaster Prevention (NIED), Japan Meteorological Agency (JMA), and stations of national universities. Earthquakes with epicenters shallower than 30 km and larger than M1.8 were used. We apply the single back-scattering model (Aki and Chouet, 1975) to the seismic waveform data from stations within 30 km of the epicenter to estimate coda Q. We take the logarithmic average of the inverse of coda Q at each station and examine temporal variations in coda Q.

As a result, the coda Q values before and after the 2011 off the Pacific coast of Tohoku earthquake show no significant temporal variations. This implies that the coda Q in the central part of the strain-concentration zone has not changed due to a large-scale change in the deformation field and is consistent with the weak zone model presented by Iio et al. (2002) and the results of Dojo and Hiramatsu (2019). In other words, a localized and persistent high deformation in the ductile regions of the crust causes a larger strain rate than the surrounding area and contributes to the formation of the strain-concentration zone.

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Keywords: Coda Q, Niigata–Kobe Tectonic Zone, Heterogeneity

