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Source modeling of the 2009 Suruga-bay earthquake based on spectral inversion and empirical Green's function method

Toshimi Satoh[1*]

[1]Ohsaki Research Institute

Stress drop of strong motion generation area is depends on short period spectral level A (or Brunes stress drop) of the earthquake used as the empirical Greens function in estimating the source model by the empirical Greens function method. Therefore we first estimate A of the 2009 Suruga-bay earthquake and the aftershocks and then estimate the source model of the main shock by the empirical Greens function method.
For spectral inversion we use strong motion records observed at K-NET and KiK-net stations at the hypocentral distance less than 80 km of the main shock and 14 moderate-sized earthquakes. The one-dimensional theoretical amplification factor at SZOH31 (Kawane) using soil constants inverted from observed surface-to-borehole spectral ratios is used as the constrain condition. Estimated Q value is modeled as $Q=30f^{0.64}$at a frequency f range from 1 to 10 Hz. This Q value is consistent with value estimated using strong motion records of crustal earthquakes and 1/3 - 1/4 times of value estimated using strong motion records of interplate earthquakes and shallow intraplate earthquakes in previous studies. For the main shock (M0=2.25E+25dyne-cm by F-net), the estimated A is 3.00E+26dyne-cm /$s^2$and the resultant Brunes stress drop is 586 bar. The A is 4.3 time of the empirical relation for the crustal earthquakes by Dan et al. (2001). In addition the A is the highest among intraplate earthquakes in the Philippine Sea plate and higher than the average of intraplate earthquakes with the same magnitude in the Pacific plate. For the aftershock (M0=6.72E+21dyne-cm by F-net) occurring at 12:42 on August 13, the estimated A is 2.08E+25 dyne-cm/$s^2$and the resultant Brunes stress drop is 621bar. For the aftershock (M0=3.90E+22dyne-cm by F-net) occurring at 18:11 on August 13, the estimated A is 1.50E+25dyne-cm/$s^2$and the resultant Brunes stress drop is 157bar.
Then we estimate source model of the main shock by the empirical Greens function method by Dan and Sato (1998). The method to estimate the source model is basically similar to Miyake et als (2003). The size and the locations of strong motion generation areas (SMGA) and are estimated based on grid search technique. The stress drop of SMGA are obtained from the A estimated by the spectral inversion. Two fault planes are assumed based on aftershock distribution estimated by ERI and NIED. The aftershock occurring at 12:42 on August 13 is used as the Greens function for the southern fault and the aftershock occurring at 18:11 on August 13 is used for the northern fault. Twelve strong motion stations are selected considering the azimuth coverage. Strong motion records of Hamaoka nuclear power plants at a depth of 100m at No.5 plant and a depth of 2m at No.3 plant as well as K-NET and KiK-net stations are used. The size and stress drop of the SMGA are estimated to be 4km*2km and 661 bar for each fault. The total size of two SMGA is 16$km^2$and is similar to 17.9km^2obtained from the empirical relation for intraplate earthquakes by Iwata and Asano (2009). The estimated stress drop is about 3 to 4 times higher than those estimated for this earthquake in previous studies. This is because A of the main shock and aftershocks are estimated to be higher due to low Q value. The difference of strong motion records of Hamaoka nuclear power plants No.3 and No.5 are reasonably reproduced using the estimated source model. However, acceleration waves at eastern stations are slightly underestimated. The possible cause is that hypocentral distances are used for the spectral

inversion and so we will conduct spectral inversion again using distance from the centroid of two SMGA.

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Keywords: the 2009 Suruga-bay earthquake, source model, empirical Green's function method, spectral inversion, Q value, strong motion generation area