The frequency structure and characteristics of the deep low frequency tremor occurring in Western Shikoku

# Sho Nakamula[1]; Minoru Takeo[2]; Kazushige Obara[3]; Yasunori Okabe[4]; Masaya Matsuura[4]

[1] ERI, Univ. of Tokyo; [2] ERI, Univ. Tokyo; [3] NIED; [4] Information Science, Univ. Tokyo

The continuous seismic tremor called the deep low-frequency tremor (LFT), which include relatively low frequency components compared to small earthquakes with the similar magnitudes, was found very recently in the Southwest Japan fore-arc, along the the subducting Philippine Sea Plate.

The source depths were about 30 - 40km, at the lower part of the crust.

The small amplitude of the LFT makes the analysis difficult and onsets of the tremor can hardly be detected.

Previous studies mainly dealt with the temporal and spatial distribution of LFT events, but this study attends to the properties of individual event.

The causes of the LFT and the slow slip which is associated with the LFT activities are thought to be related with fluids from the subducting plate.

However, these properties discussed only from the qualitative side and the physical mechanism of the tremor associated with fluids is not clear. Extremely small amplitudes of the tremor make the onsets detection very difficult and the hypocenter locations become less accurate. A determination of the focal mechanism like an earthquake is thus impossible. For the difficulty of applying methods commonly used for analyses of earthquake, an appropriate source model has not yet been constructed.

Since it is difficult to obtain useful information by applying the common method, we should think of the way to extract the meaningful information from the low signal/noise ratio data.

A method of time series analysis is effective to elucidate the physical mechanism of the LFT. By the separation of the signal from noise and to get the parameters which characterize the time series of the LFT, we can estimate the time evolution of the data and this can be strong help to deduce the physical mechanism of the deep low-frequency tremor.

However, the waveforms of the LFT signal are low and little information about the physical process of LFT is available. Therefore we should suppose a priori assumption before analysis as little as possible. In this sense, we use the theory of KM_2O-Langevin equations developed by Okabe et al. for the analysis. This theory is based on the fluctuation-dissipation theorem which is one of the principles of statistical physics. The advantage of using this theory is that we require no prior information about the data and do not have to define any parametric models like AR-model or ARMA-model before analysis.

The matrix functions which characterize the time series are extracted directly from data itself, checking the stationary property of the data.

We applied the time series analysis based on this theory to the waveform data of the deep low-frequency tremor recorded at the Shikoku region, and obtained the various properties of the LFT.

We developed the automatic phase detecting and picking algorithm using the stationary analysis and built it in the method of automatic hypocenter determination of the LFT. The obtained hypocenter distribution was in the valid range whose focal depths were approximately about 30km.

We also obtained the discrete spectrum in complex frequency space which characterize the LFT signal by the method of ``Average Dissipation Spectrum (ADS)'' based on the thory of KM_2O - Langevin equations.

Several peaks existed from 1.3Hz, 1.75Hz, 2.3Hz, 2.8Hz, 3.2Hz, 3.8Hz, 4.3Hz in the dominant frequency range 1-5Hz of the LFT. The decay rate of the LFT is about 0.20 for the data of 2003 and 0.15 to 0.18 for the data of 2002. The effect of regional crustal structure was also confirmed and we conclude that these characteristics come truly from the source of the LFT, not from the effect of the crustal structure.