

Spatio-temporal distribution of similar earthquakes in the Kanto-Tohoku district

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In addition to the frequent occurrences of large interplate earthquakes, background seismicity is also high in the Japan subduction zone. Most of these background earthquakes and aftershocks of large events around the plate boundary are not occurring randomly in space but separated into many clusters. There are also many seismic activities with volcanic activity or fault movement in the land area and Japan Sea. If each cluster is composed of earthquakes occurring closely with the same focal mechanisms, these earthquakes must have the same waveforms. We analyzed small earthquakes occurred in the subduction zone in the Tohoku district, and found many similar earthquakes. These are classified into 'continual-type' and 'burst-type'. The clusters belonging to the continual-type are seen in the background seismicity. In particular, many clusters were found in the deepest part in the occurrence region of the low-angle thrust fault type earthquakes. Occurrence rates of the events correspond to the subducting rate at the Pacific plate. The most typical example of the continual-type cluster is the cluster off Kamaishi, Iwate Prefecture; in this cluster, M4.8 events have repeatedly occurred with almost constant interval of about 5.5 years. They suggested that continual-type clusters occurred in repeatedly sliding by the stress concentration in small asperities surrounded stable-sliding region. On the other hand, the burst-type clusters are prominent in the swarm or aftershock activities, and one cluster showed the change of the occurrence time interval corresponding to the after-slip.

The occurrence of the similar earthquakes may show locally slip condition in the seismogenic zone and the relation to generation of large earthquake. In this study, we investigated the nature of the earthquake clusters by analyzing the similarity among the waveforms of the events in the range of Kanto-Tohoku district. In this time, we investigate also the characteristics of the spatio-temporal distribution of the earthquakes occurred in the shallow part of the land area and the Japan sea, and we compared with the subduction zone in th Tohoku district.

We used waveform data recorded by the seismic network of the Earthquake Research Institute (ERI), the University of Tokyo, and the microearthquake observation network of Research Center for Prediction of Earthquakes and Volcanic Eruptions (RCPEV), Tohoku University. The method used in the waveform similarity analysis is as follows: (1) Search earthquake pairs whose horizontal intervals are less than 10 km. (2) Calculate cross-correlation coefficients of 1-4 Hz band-pass filtered seismograms between the paired events. We set the length of the time window from P-wave onset to the time over three seconds after S-wave arrival. (3) Treat the paired earthquakes as 'similar events' if the coefficients calculated for plural stations are greater than 0.95. (4) Applying these procedures to all the pairs, classify the events into several groups. The data analyzed here are for the 11 years from January 1991 (ERI) and April 1992 (RCPEV).

As a result of the present analysis, we also found that many similar earthquakes are included in the clusters on the plate boundary in the Kanto district. In particular, the similar earthquakes activities in off Ibaraki area are more active than off Fukushima area. Furthermore, many similar earthquakes found in the depth of 50 km and 70 km beneath Ibaraki Prefecture. We also found many similar earthquakes in shallow part in the land area and the Japan Sea. Although, the most of these classified into burst-type. In Nikko-Ashio area, swarm activity have continued for a long period, and many similar earthquakes are found, but these are only burst-type. Only continual-type activity in the intermediate-depth earthquake was seen in the depth of 150 km beneath Niigata Prefecture, and other areas are found doublet only.