

Repeating earthquake activities in and around the Japanese Islands

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Small repeating earthquakes, which repeatedly occurred in almost the same place with the same focal mechanisms, give important information on recurrence characteristics of earthquakes and slip of plate interface. We investigate spatio-temporal distributions of small repeating earthquakes in and around the Japanese Islands including the subducting Pacific plate, the subducting Philippine Sea plate and shallow earthquakes beneath land area.

We basically applied the procedure for extracting small repeating earthquakes and estimating their slip rates by Igarashi et al. [2003]. However, three band-pass filters at 1-4 Hz, 2-8 Hz and 4-16 Hz were used for analyzing earthquakes of magnitude 2.0 or greater. Events selected from JMA hypocenter catalogue. We analyzed waveform records of all stations operated by the NIED, JMA, and ERI, University of Tokyo. Analysis periods are about 28 years from July 1981 to the present time, although this period is different by region. Hokkaido and the Nansei islands are the shortest periods for about 7 years after 2002. We also compiled small repeating earthquake catalogue of the northeastern Japan region for the period from July 1984 to July 2000 by Igarashi et al. [2001; 2002; 2003].

As a result, many repeating earthquakes are located in the upper boundary of the subducting plate of the Pacific plate from Hokkaido to Ibaraki prefecture and the Philippine Sea plate around the Kanto district and from Kyushu district to Nansei Islands. There are mostly located in the deeper part in the occurrence region of the low-angle thrust fault type earthquakes. Their sequences have long-term duration and repeated constantly. Furthermore, we visualized slip distribution in the plate by interpolating slip rates estimated from small repeating earthquakes. Their estimated slip rates are consistent with the slip velocity of the subducting plates. Their distributions represent spatio-temporal changes of post-seismic slip after some large earthquakes and inter-plate coupling.

On the other hand, they were not found in the intermediate-depth earthquakes, the Izu-Ogasawara subduction zone and asperities of large inter-plate earthquakes with a few exceptions. Seismic clusters in about 150 km deep beneath Niigata prefecture include sequences constantly-repeated. Sequences around this area show extraordinary activities into the seismogenic region of the intermediate earthquakes. There may be too little stations and seismic activities for analysis in the Izu-Ogasawara region. Several repeating earthquakes are also found in shallow part beneath land area. They located within high seismicity area near volcano and/or seismic fault. Most of these groups were burst-type activities even if swarm activity has continued for a long period within the region. However, some continual-type sequences might be included.

Small repeating earthquakes in the Philippine Sea plate boundary from Tokai to Nankai area, which generated giant earthquakes periodically on about 100-200 years interval and low frequency tremors, are sparse distributed. The present seismicity is not active and small earthquakes hardly occur in the plate boundary in this region. However, many burst-type sequences occurred from 20 to 40 km depth are correspond to the deeper edge of source regions of large interplate earthquakes, although they were not only seen in subducting plate but also found them in overriding plate and intra-plate. They did not occur in the periods of slow slip events or deep low-frequency tremor. Therefore we suggest that they related with the rapid stress changes by slip condition in the plate (or plane) boundary. The period we analyzed may be short as compared with repeating intervals of large earthquakes. We should be investigated the relation between repeating sequences occurred in the intra-plate and plate coupling in detail as further studies.