1P2-12

The Hypocenter structure of the earthquake off the southeast coast of the Kii Peninsula and its primary source

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1. Introduction

There are several ocean areas in the central ocean where earthquakes are frequently observed. Not only are the hypocenter regions of these earthquakes limited in area, but they are also clearly divided into two depth ranges. A typical example of this is the area off the south-east coast of the Kii Peninsula[1,2). We analyze their roles from the viewpoint of Statistical Energy Analysis (SEA). That is, this dichotomous hypocenter structure is energetically related[3)]. Furthermore, we investigate the occurrence time of earthquakes to obtain the characteristics of earthquakes occurring in the deep hypocenter region, and show that there is a temporal and seasonal bias[3)]. Among them, pulse-like occurrences of magnitude 5 or so occur almost periodically every year. This suggests that they occur with the subsidence of the oceanic plate, and is therefore considered to be a source of sound for earth activity, i.e., a primary sound source for SEA.

2. Hypocenter structure and interactions

Figure 1 shows the depth distribution of earthquakes that occurred in the southeast offshore Kii Peninsula in 2004. The horizontal axis is the time elapsed from New Year's Day. The vertical axis is the focal depth of the earthquakes. As is clear from the figure, the focal region is clearly separated into a group of earthquakes at a depth of 50 km or less and a group of earthquakes at a depth of 300 km or more.

2.1 Energy transition

The focal region southeast of the Kii Peninsula is divided into two regions in terms of depth. Furthermore, as described below, the stress effects of these zones have also been observed[3)]. To clarify the relationship between the deep and shallow hypocenter regions, we investigate the energy transition between them.

The energy E (Jules) of an earthquake is expressed by the following formula[4)].

$$\log 10\ E = 4.8 + 1.5\ M \qquad (1)$$

M is the magnitude. The cumulative energy of the earthquakes that occurred in 2016 off the southeast coast of the Kii Peninsula is shown in **Fig. 2**.

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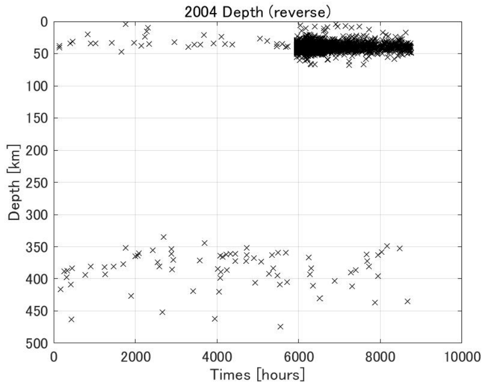

Fig.1 The time distribution of the focal depth of the earthquake that occurred off the southeastern coast of the Kii Peninsula in 2004.

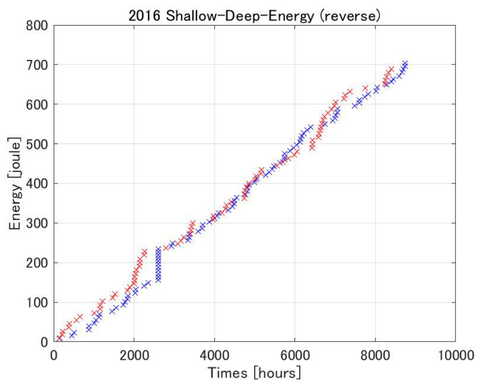

Fig.2 Accumulated energy of the Kii Peninsula southeast offshore earthquake in 2016.

The horizontal axis is the elapsed time with New Year's Day as 0, and the vertical axis is the cumulative energy of earthquakes that occurred from New Year's Day. The cumulative energy of 76 earthquakes with magnitudes between 1.5 and 3.7 that occurred in the deep region is represented by a + sign. The cumulative energy of 86 earthquakes with magnitudes between 1.5 and 3.1 that occurred in the shallow region is represented by a + sign. As is clear from the figure, despite the difference in the number of earthquakes in the two hypocenter regions and their range of magnitudes, not only the rate of increase in the cumulative energy in the two hypocenter regions but also the detailed fluctuations are consistent.

For example, the cumulative curves from 2000 hours to 2600 hours for the deep earthquake and the shallow earthquake are parallel. In other words, the shallow earthquake occurred about 450 hours after the deep earthquake. Such a change clearly indicates the flow of energy, and since it cannot be observed between two different hypocenters, the peculiarity here is noteworthy.

4. Time of occurrence

In the previous section, the flow of energy from deep to shallow regions became clear. The source of the earthquake is in the deep hypocenter region. Therefore, to investigate the seismic structure in the deep regions, we calculate the scale and time change of magnitude of earthquakes that occurred, and the results are shown in **Fig. 3**. After earthquakes of magnitudes M4, 3.9, and 3.8 occurred at intervals of about 1000 hours, a M4.2 earthquake occurred, followed by a sudden quiet period of about 1500 hours (arrow). This quiet period coincides with the initial range of the M7.4 earthquake that occurred in the shallow area on September 5th, as shown in Fig. 1. The energy flow shown in the previous section propagated from the deep area to the shallow area. However, the occurrence of the quiet period in Fig. 3 indicates that a reaction force is generated from the shallow area to the deep area. To investigate the mechanism of earthquake occurrence in the deep region, we investigate the distribution of earthquakes occurring annually [3], and the results are shown in **Fig. 4**(a)(b). Pulse-like occurrences of magnitude 5 or greater (red circles) can be seen in all of them. These pulse-like occurrences were observed every year from 2004 to 2020. The pulse occurrence period is approximately a year, and the occurrence times of the preceding earthquakes are almost the same, as shown in the figure. The date and time of the occurrence corresponds to the summer solstice.

Summary

The interrelationship between the energy flow and strain generated in the deep and shallow hypocenter regions was investigated. The energy flow was shown to be directional from the deep region to the shallow region, but it was shown that the stress of the crustal strain should also consider the reaction from the shallow region to the deep region. The occurrence time of earthquakes also changes over time and seasons. Pulse-like earthquakes of about

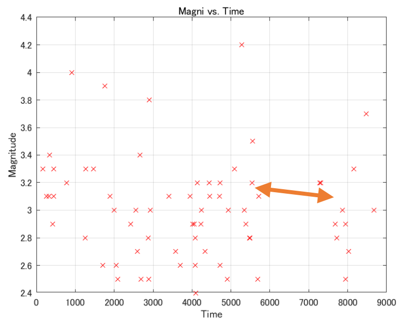

Fig.3 Time distribution of the magnitude of earthquakes that occurred in 2004

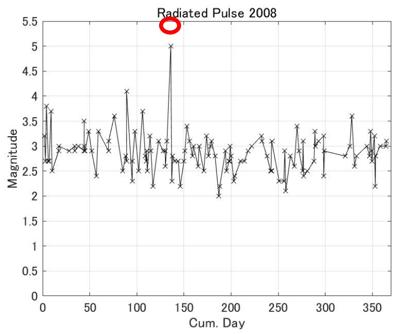

Fig.4(a) Distribution of earthquakes that occurred in deep hypocenter regions in 2008

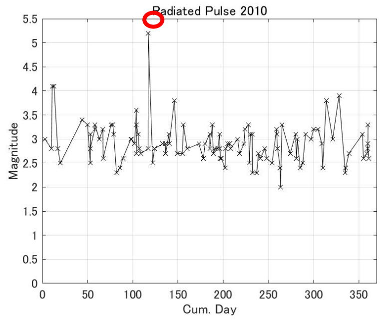

Fig.4(b) Distribution of earthquakes that occurred in deep hypocenter regions in 2010

M5 are observed annually. From these findings, it be became clear that the deep focal region corresponds to a SEA-like sound source. This made it possible to construct a SEA-like propagation model, and an earthquake prediction model.

References

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3) T. Kikuchi Proc. Mar. Acoustic. Soc. Jap. 2024, 24-24
4) Wikipedia, Magnitude Scale