2016 年三重県南東沖地震（Mw 5.9）と南海トラフ巨大地震の準備過程

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1. Introduction

Megathrust earthquakes have occurred repeatedly at intervals of 100 to 150 years along the Nankai Trough, situated in the southwest of Japan. Given that it has been 70 years since the last event, the occurrence of the next devastating earthquake is anticipated in the near future. On April 1, 2016, a moderate earthquake (Mw 5.9, MJMA 6.5) occurred off the southeastern coast of Mie Prefecture in the source region of the 1944 Tonankai earthquake (Mw 8.2). In this study, we investigated the influence of the 2016 earthquake on future megathrust earthquakes.

2. Method

We first determined the hypocenter distributions using a precise velocity structure obtained from seismic surveys in the source region. We determined the hypocenters of the mainshock and aftershocks of the 2016 off-Mie earthquake using a horizontally heterogeneous velocity structure obtained along a survey line that passes through the hypocentral region.

We then performed a preliminary numerical simulation to reproduce the occurrence of a moderate earthquake in the middle of a megathrust earthquake cycle. We used a hierarchical asperity model, in which smaller asperities causing moderate earthquakes are embedded in a hyper-asperity that serves as the source region of megathrust earthquakes.

3. Results and discussion

Using data obtained from the DONET ocean-bottom observation network, we found that this earthquake occurred along the plate boundary fault, which is also believed to have slipped during past megathrust earthquakes. The hypocenters were distributed several kilometers shallower than those based on hypocenter determinations using a 1D velocity structure. The mainshock depth was 9.2±0.6 km below sea level, about 4 km shallower than that obtained by the routine analysis, and about 2 km shallower than that obtained by Wallace et al. (2016). Aftershocks were distributed in a very limited area, about 10 km downdip of the mainshock, at depths of between 10 and 14 km, with source location errors of 1.9 km in both horizontal and depth directions. There is a seismic gap distinct from the mainshock hypocenter.

The simulation shows that moderate earthquakes along the plate boundary, caused by ruptures of a smaller asperity, occur as a result of shrinkage of strongly coupled areas in the hyper-asperity. This result is consistent with the observation that the hypocenter of the 2016 earthquake was located at the edge of a strongly coupled region along the plate boundary. The simulation also reproduced postseismic slip (afterslip/slow slip) along the plate boundary updip of the hyper-asperity, which is consistent with the observations of slow slip events and very-low-frequency earthquakes after the 2016 earthquake. Thus, the occurrence of the moderate earthquake offshore southeastern Mie Prefecture in the middle of the megathrust earthquake cycle implies that the shrinkage of the strongly coupled area along the plate boundary is occurring as a preparatory process for the next megathrust earthquake in the region (Nakano et al. 2018).

References

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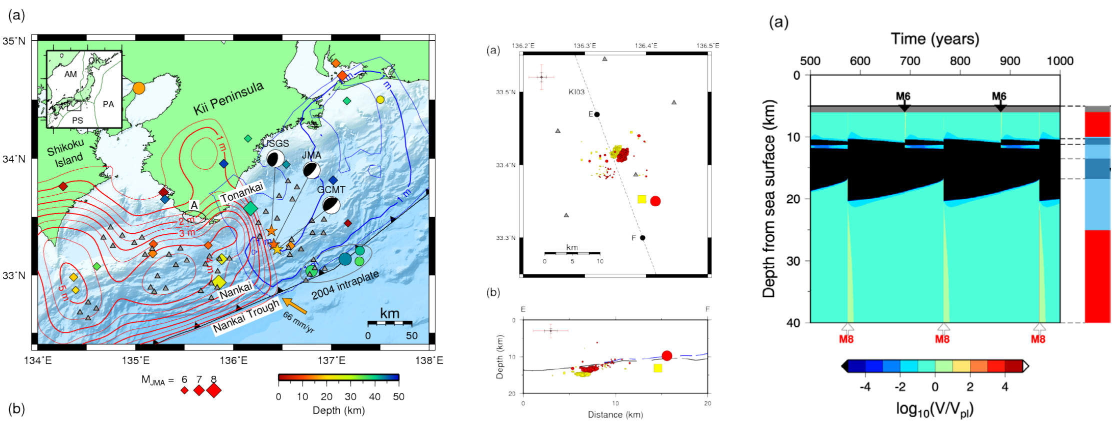

Fig. 1. (Left panel) Regional location map (inset) and seismic activity along the Nankai Trough. Orange star represents the epicenter location of the 2016 off-Mie earthquake. Results from JMA, USGS, and GCMT are shown. Blue and red contours represent the slip distributions of the 1944 Tonankai and 1946 Nankai earthquakes, respectively (Ichinose et al. 2003; Murotani et al. 2015). Gray triangles represent locations of DONET stations. (Middle panel) Comparison of routine and relocated hypocenter locations. Yellow and red circles represent routine and relocated hypocenters, respectively. (Right panel) Spatiotemporal evolution of the slip rate V during the resultant earthquake cycles. Colors denote the slip velocity. Arrows denote occurrences of earthquakes with denoted magnitude. (Figures from Nakano et al., 2018)