Investigation of multi-segment earthquake on the Itoigawa-Shizuoka Tectonic Line active fault zone based on dynamic rupture simulation

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The Itoigawa-Shizuoka Tectonic Line active fault zone (ISTL) in central Japan is one of the most active fault zone in Japan. To discuss the possibility and condition of multi-segment earthquakes in the ISTL, we construct dynamic rupture models for the north-central and south-central portions of the ISTL based on geological and geophysical data.

The previous studies based on seismic reflection, seismic refraction, and gravity surveys suggested that the north-central and south-central portions of the ISTL are east-dipping(e.g. Hagiwara et al., 1986; Ikami, et al., 1986; Sato et al., 2004) and west-dipping (e.g. Hirakawa et al., 1989; Kumamoto and Ikeda, 1993; Karino et al., 2004) faults, respectively, however, the dip angles were obscure. Using FEM modelling, the Ministry of Education, Science, Sports and Culture (MEXT) and National Institute of Advanced Industrial Science and Technology (AIST) (2020) proposed that the dip angles of the portions were vertical. Based on the proposed fault geometry, the north-central and south-central portions of the ISTL are modeled as vertical left-lateral strike-slip fault planes in this study. The lengths of the fault planes are 34 km and 26 km, respectively, and the south-central portion bend at 5 km from the northern end.

Azimuth of the maximum principal stress and stress ratio are assumed, considering the stress inversion result (MEXT et al., 2010) and the FEM modelling (MEXT and AIST, 2020). Surface slips of the latest events on each portion were observed at three locations of the north-central portion (Okumura et al., 1994; Kondo et al., 2006; Kondo et al., 2019) and a location of the south-central portion (Miura et al., 2004) by trench surveys. Four initial crack locations, the north and south ends of both portions, are assumed. Varying depth coefficient of stress drop, we calculate dynamic rupture processes by a finite-difference method (Kase and Day, 2006), and compare the left-lateral slips with the observed ones.

The ruptures initiating at the north or south end of the north-central portion can jump to the south-central portion. Even a multi-segment rupture on the north-central and south-central portions, however, needs quite a large stress drop for surface slips on the north-central portion to be consistent with the observed ones. The result implies that the latest event on the north-central portion was likely a multi-segment earthquake including the north portion, which agrees with paleoseismological data (MEXT and AIST, 2020). On the other hand, the ruptures initiating at the north or south end of the south-central portion cannot jump to the north-central portion. The slip of the single event on the south-central portion needs a large stress drop to be consistent with the observed one. The latest event on the south-central portion may be a multi-segment earthquake on the south-central and south portions, which is suggested by paleoseismological data (MEXT and AIST, 2020).

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