Rupture processes of the 2016 Kumamoto earthquake sequence: Causes for extreme ground motions

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The 2016 Kumamoto earthquake sequence including three large events (M6.5 on April 14, M6.4 on April 15, and M7.3 on April 16) caused severe damage to the Kumamoto prefecture and surrounding region. During the M7.3 event, extreme pulse-like velocity waveforms were observed in the town of Mashiki and the village of Nishihara. To investigate the rupture processes of the 2016 Kumamoto earthquake sequence and causes for these pulse-like waveforms, we performed the joint source inversions of the three notable events using strong motion, teleseismic, and geodetic data.
We constructed multi-segment faults models for the three events. We first relocated the hypocenters of the sequence by double difference method [Waldhauser and Ellsworth, 2000]. Considering the relocated hypocenters distributions, focal mechanisms, and active faults, we divided the source region into four regions. Four regions correspond to the Hinagu fault zone, the junction of the Futagawa and Hinagu fault zones, the Futagawa fault zone, and the inner Aso caldera. We also adjusted the one-dimensional velocity structure models for strong motion stations using five medium-sized earthquakes.
The obtained results are following: 1) The M6.5 event initiated on southeast dipping fault and then ruptured the Hinagu fault toward southwest; 2) The M6.4 event initiated on the Hinagu fault and ruptured the adjacent region to the M6.5 rupture area; 3) The M7.3 event initiated on the deep part of the Hinagu fault and propagate to northeast along the Futagawa fault; 4) Extreme ground motion observed in the town of Mashiki and the village of Nishihara can be attributed to the event's upward rupture directivity and fast slip rate.

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