Complex rupture termination, strain partitioning and dispersed stress transfer associated with the 2016 Kumamoto earthquake, Kyushu, Japan

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The Mw=7.0 16 April 2016 Kumamoto earthquake ruptured ~30-km-long active fault zone of the previously mapped Futagawa and northern Hinagu fault systems with up to 2.4 m dextral slip. The mainshock was followed by a significant number of aftershocks which occurred not only along the source faults but also off-fault regions, reaching the city of Oita ~70 km northwest and Yatsushiro ~50 km southwest of the edges of the rupture zone immediately after the mainshock. Can these widespread aftershocks be explained by the conventional static stress transfer? Is this extensive activity highly likely to ignite a nucleation to another large event in central Kyushu? To answer these questions, here we explore various stress calculations with the observed seismicity and focal mechanisms, considering the complex fault geometry and geologic structure.
We first calculate the static Coulomb stress change caused by the 16 April 2016 Mw=7.0 Kumamoto earthquake and its larger foreshocks. We found the NE-trending dextral strike-slip faults and EW-striking normal faults beyond the edges of the rupture zone were brought significantly closer to failure, which is consistent with the observed aftershock distribution. One of the significant features is the abundant normal faulting aftershocks beneath the city of Kumamoto, an area of 30 km x 30 km, where Y shaped branching geometry composed of the Futagawa fault and the Hinagu fault systems that has developed a subsiding graben, the Kumamoto plain during the late Quaternary period. We interpret that this large-scale horsetail end, like "Japanese bamboo besom" plays an important role not only as a barrier to stop the dynamic rupture but also as dispersing and escaping the transferred stress. This "Japanese bamboo besom" like distribution at the edge of a large earthquake rupture, contributing to strain partitioning for the NS extension of the entire region, makes a striking contrast to earthquake ruptures on a simple continuous large fault system such as the San Andreas fault in California and the North Anatolian fault in Turkey. Even though we still do not know if the next rupture in Kumamoto would occur soon, such a structural contrast provides us a clue to evaluate the effect of stress transfer to a successive rupture on the next segment along a fault system.

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