

Modeling the spatiotemporal change in stress field around Hinagu fault zone through the 2016 Kumamoto earthquake sequence, in central Kyushu, Japan

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For a purpose of understanding physical process of earthquake generation, knowledge of stress condition around a fault is required. We estimated stress field and discussed its spatiotemporal change around Hinagu fault zone that was the hypocentral area of the 2016 Kumamoto earthquake sequence.

The 2016 Kumamoto earthquake sequence occurred around Hinagu and Futagawa fault zones in Kumamoto prefecture, central Kyushu Island, Japan. The largest foreshock with Mj 6.5 (Mj: magnitude by Japan Meteorological Agency) on April 14, 2016 was located Hinagu fault zone. The mainshock (Mj 7.3) generated slip at both Hinagu and Futagawa fault on April 16, 2016. After that, many earthquakes occurred around these faults until now.

In this study, we estimated the spatiotemporal change in the deviatoric stress field and its differential stress. For discussing the temporal change in the target region, we divided time sequence into three periods: (1) prior to the sequence (i.e. before Mj 6.5 event), (2) between the foreshock and the mainshock, and (3) after the mainshock. We compared the deviatoric stress fields with the co-seismic stress change by faulting of this sequence. From focal mechanism solutions from January 1, 1993 to December 31, 2017, we estimated the deviatoric stress field using the method by Matsumoto [2016]. We adopted fault slip models of the fore- and mainshock, which is the slip distribution projected result by Asano and Iwata [2016] on the fault geometries determined from the distribution of hypocenters. We performed a grid search procedure for the differential stress at each spatial block with horizontal size of 0.05° in latitude and longitude, and 5 km in depth.

As a result, we captured the stress condition in the both period (1) and (3). Before the foreshock (i.e. period (1)), the differential stress around the fore- and mainshock faults is higher than the other region, its value is from several MPa to several tens of MPa. On the other hand, the differential stress in south area of Hinagu fault zone ranges from about 0.1 to 1 MPa. We found the foreshock and mainshock occurred in the state of high differential stress.

After the mainshock (i.e. period (3)), the spatial heterogeneity of the differential stress still remained. However, the differential stress at the area around the hypocenters of the fore- and mainshock is about half of that before the foreshock. At the southeast area of Hinagu fault, the differential stress is about twice of that before, so potential of occurring earthquake becomes relatively high compared with the prior state to this sequence.

Keywords: 2016 Kumamoto earthquake, stress field, fault strength