Spatiotemporal variations of stress field in the 2016 Kumamoto earthquake (M 7.3) area

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Focal mechanism solutions of 349 local crustal earthquakes and stress tensors in central-north Kyushu are determined using a large number of P-wave polarity data and a 3-D velocity model. The obtained tensional (σ3) axis trends NNW-SSE or N-S horizontally, and the compressive (σ1) axis trends WSW-ENE or E-W. The direction of the σ3 axis is consistent with the spreading direction at the Okinawa Trough. The stress field in the 2016 Kumamoto earthquake area is attributed to rollback of the Philippine Sea plate and northward extension of the Okinawa Trough. The orientation of the σ3 axis is quite stable, whereas the σ1 and σ2 axes are distributed in a wide range. With the 3-D velocity model, the principal stress axes can be better determined by inverting a large number of FMSs. Spatial and temporal variations of the stress field are well revealed in the Kumamoto source area. The σ3 axis significantly rotated counterclockwise after the M 6.5 foreshock, and rotated clockwise after the M 7.3 mainshock on the Futagawa fault segment. The stress rotation suggests a small magnitude of deviatoric stress in the source area, which indicates a small friction coefficient on the seismogenic faults. In addition, a generally small value of friction (~0.4) on the faults is obtained by the stress inversions, indicating that the faults in the Kumamoto earthquake area are weak. The fault weakening may be caused by the arc magma and fluids ascending from the mantle wedge associated with the dehydration reactions of the subducting Philippine Sea slab.

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