Stress tensor inversion in the focal area of the 2016 M_w7.8 Kaikoura earthquake, New Zealand (4)

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We study spatio-temporal change of the stress field due to the 2016 Kaikoura earthquake in the northern area of the South Island of New Zealand. Data from both 51 temporary stations and 22 permanent GeoNet stations were used. From these data, we determined focal mechanisms and estimated the stress field before and after the Kaikoura main shock using stress tensor inversion. If there are many aftershocks on the fault plane of the main shock, the fault plane may be distributed with a bias. Therefore, it is necessary to study the effect of focal mechanisms of aftershock that occurred on the fault plane of the main shock. So, we attempted to remove the mechanism solution on the fault plane of the main shock using the fault model of Hamling et al. (2017) and Kagan angle.

We found that the stress field did not change significantly independent of the value of the Kagan angle, and we consider that the effect of the aftershocks occurring on the fault plane of the main shock on the result is small. In addition, we carried out the analysis by dividing the epicenters into several regions. We obtained the following results: 1) In the southwest part of the rupture, the stress field changed from strike-slip before the main shock to a stress field overlapping sigma-2 and sigma-3 (between strike-slip and reverse fault type) after the main shock. The stress ratio (phi) changed from 0.4 to 0.2. 2) In the central part of the rupture, the stress field changed from a stress field overlapping igam-2 and sigma-3 (between strike-slip and reverse type) prior to the main shock, to strike-slip type after the main shock. The stress ratio changed from 0.2 to 0.5. 3) In the northeast part of the rupture, the stress field changed from unstable before the main shock to a more stable strike-slip type afterwards. The stress ratio changed from 0.2 to 0.4. 4) When finely segmenting the stress field after the main shock, the solution of the stress field tended to be unstable in the area near where the strike changed in the fault model of Hamling et al. (2017). The stress ratio typically takes a value between 0 and 0.3 in the area where the solution of the stress field becomes unstable.

When the solution of the stress field becomes unstable and the stress ratio is low, there are two possible causes: the effect of pore fluid pressure (c.f. Warren-Smith et al., 2019) and the heterogeneity of stress due to the main shock. As for the latter, in the southeastern area and fault-intersection area, as shown by the fault model of Hamling et al. (2017), the strike and slip angle of each small fault are not uniform, so inhomogeneous slip may affect the result. Therefore, the change in stress in the depth direction will also need to be examined. We plan to quantitatively determine the ease of movement of each fault by using the obtained stress field and slip tendency.