Spatio-temporal variation of seismogenic stress field in the source region of the 2004 Sumatra-Andaman earthquake

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After the 2004 Sumatra-Andaman earthquake (Mw9.2), many aftershocks occurred around the source region. Aftershocks source mechanisms show a huge variety of source mechanisms and occur in clusters. Their distribution is different from that before the main shock. This change of seismicity pattern suggests that the coseismic stress change had a significant influence on the stress field around the source region. In this study, we compare the seismicity pattern and the stress change pattern due to the main shock to discuss possible triggering and suppressing of seismic activity.

We investigate whether aftershock activity were triggered or suppressed by the main shock using CFF change. We focus on 4 characteristic clusters of aftershocks. We assume the main shock slip distribution along the plate boundary and calculate CFF change distribution for the target source mechanism.

In the northern part of the source region, the normal fault earthquakes occurred just beneath the trench. On the other hand, high angle reverse fault events occurred beneath the trench in the southern part. Triggering of the high angle reverse fault events is possible for very limited cases when the coseismic slip extends close to the trench axis and suddenly decreases to zero. In the case a positive CFF change for high angle reverse faults extends down ward from the trench. Distribution of the large uplift which was estimated from tsunami observation corresponds to the distribution of high angle reverse faults just beneath the trench, supporting own speculation.

In the Sumatra region, normal fault events occurred about 120km northeast from the trench. These events are located several km under the plate boundary. Considering the depth error of hypocenter determination, we cannot judge if these events occur on the hanging wall side or the foot wall side. On the other hand, these normal fault events occurred in a very limited time period, within about 5 days after the main shock. The deep afterslip, which is suggested by GPS observation, causes negative CFF change in the hanging wall side and positive CFF change in the foot wall. Thus we suspect that these normal fault events occurred in the hanging wall side and were suppressed by the deep afterslip.

Because the 2004 Sumatra-Andaman earthquake was too large, the detail rupture process can not be obtained by the common analysis techniques. Furthermore, modern observation instruments are not installed near the source region. However we successfully demonstrate that aftershocks are a good indicator of stress field and are very useful for estimating local or detailed feature of the main shock rupture, which is impossible with commonly used techniques.