C-values of an activated seismicity due to a large earthquake

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A stress change due to a large earthquake modulates the seismicity around the source region. Relationships between seismicity rate change and stressing rate change have been reported by theoretical and observational studies (e. g., Dieterich, 1994; Toda et al., 2002). The Tamba region, southwest Japan is located to the northeast of the rupture zone of the 1995 Hyogo-ken Nanbu Earthquake (Mjma 7.3). In the Tamba region, the seismicity was activated by the coseismic static stress change (+20kPa; Hiramatsu et al., 2000) due to the earthquake. In this study, we compare c-values, a parameter of the modified Omori law, estimated by the maximum-likelihood method (Ogata, 1983) to those by the rate- and state- friction law (Dieterich, 1994). We use earthquakes greater or equal to M 1.5 from the occurrence of the earthquake (17 January 1995) to December 1995 from the earthquake catalog of the DPRI, Kyoto University. We divide the analyzed region from the Tamba region to the western area of Lake Biwa into two regions, the southwest region next to the rupture zone and the northeast region.

The obtained p-values, a decay rate of aftershock, are 1.0 in the both regions. These results show that the seismicity in the both regions after the earthquake is explained by the Omori law (p=1). This indicates that the seismic activity in the analyzed region after the earthquake is regarded as an aftershock type activity. The obtained c-values of the southwest and the northeast regions are 236.9 and 4818.0, respectively. In the case of dividing the southwest region into two subregions like above, the obtained c-values of the southwest and the northeast sides are 73.8 and 666.7, respectively. The c-values of the region distant from the rupture zone are larger than those of the region close to the rupture zone. If we assume that A$*$sigma (A is the fault constitute parameter and sigma is the effective normal stress) (Dieterich, 1994) and the reference stressing rate are constant, the c-value depends only on the value of the stress change based on the rate- and state- friction law. In this study, we use parameters that A$*$sigma is 9.7 kPa and the reference stressing rate is 0.5 kPa/year estimated from the seismicity rate change in the Tamba region between before and after the Hyogo-ken Nanbu earthquake and the static stress change due to the earthquake (Sugaya et al., 2008). Because the values of dCFS due to the earthquake in the southwest and northeast regions are about + 30 kPa and about + 5 kPa, the estimated c-values of the southwest and the northeast regions using the rate- and state- friction law are 321.3, and 4228.9, respectively. These values are consistent with those estimated using the maximum-likelihood method.

The rate- and state- friction law constructed by the laboratory experiment has been examined by the seismicity rate change between before and after a tectonic event and the stress change due to an event (e. g., Toda et al., 1998; 2002). The results of this study show that the friction law is applied to natural earthquakes from the view of c-values. We thank Yosihiko Ogata for useful discussion.