Spatiotemporal Variations of Taiwan Seismicity Before and After the 1999 Chi-Chi, Taiwan, Earthquake

Satoru Nagai[1]; Naoshi Hirata[1]

[1] ERI, Univ. Tokyo

The island of Taiwan is located in the site of an ongoing arc-continent collision boundary between the Eurasian and the Philippine Sea Plates with a convergent rate of about 7 - 8 cm/yr [Seno et al., 1993]. Around Taiwan, the interaction of this collision is complicated and gives a rise to a very complex tectonic structure and crustal activities including high seismicity. The 1999 Chi-Chi, Taiwan, earthquake (Mw7.6) occurred on September 20, 1999 (UT) in central Taiwan. Numerous aftershocks and triggered seismicity followed the Chi-Chi Earthquake. These seismicity changes can be interpreted as effects of stress changes induced by large earthquakes, such as the Chi-Chi earthquake. Dieterich [1994] formulated seismicity rate change as a function of stress step change with a rate- and state- dependent friction law. We have investigated the relationship between spatiotemporal variations of seismicity and static stress changes before and after the Chi-Chi earthquake. In this study, we reinvestigated a Taiwan earthquake catalog determined by Central Weather Bureau from 1991 to 2003 with magnitude of 2 or greater.

We focused on two regions, in both of which remarkable seismicity change were observed after the Chi-Chi earthquake and separated from other activities easily. In a region around 24.0N and 121.3E, east of the Chi-Chi earthquake, background seismicity rate and seismicity rate for 1 day after the Chi-Chi earthquake were calculated 0.03 events/day and 73 events/day, respectively. Therefore, ratio of seismicity rate before and after the Chi-Chi earthquake was calculated about 2500. From Dieterich's formulation, we can explain temporal change in seismicity rate in this region with parameter of aftershock duration ta of about 1000 years and estimated the product of fault constitutive parameter A and normal stress at about 0.06 MPa, which was inferred from 0.5-MPa shear stress increase on the fault plane associated with this activity with by Chi-Chi earthquake. In another region around 24.0N and 120.7E, west of the Chi-Chi earthquake, background seismicity rate and seismicity rate for 1 day after the Chi-Chi earthquake, and ratio of seismicity rate before and after the Chi-Chi earthquake were calculated 0.02 events/day, 20 events/day and about 1000, respectively. Therefore, we can explain temporal change in seismicity rate in this region with parameter of aftershock duration ta of 1000 - 2000 years and estimated the product of fault constitutive parameter A and normal stress at about 0.164 MPa inferred from 1.10-MPa shear stress increase.

Finally, we checked spatiotemporal variation of seismicity in these two regions. There is no significant earthquake with magnitude of 6 or greater around both regions. There are 6 earthquakes with magnitude of 5 or greater in the eastern region and 4 earthquakes with magnitude of 5 or greater in the western region and all of them occurred for 2 months after the Chi-Chi earthquake. Distinct spatial change in eastern seismicity was not observed. However in western region, remarkable spatial change as northern extended seismicity was observed after the Chi-Chi earthquake. This extended seismicity can be interpreted as reactivation in deeper extension of the Chunghua fault, which is one of major thrust faults in Taiwan, because of new stress accumulation after the Chi-Chi earthquake.

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