Depth and cut-off M dependence of the decay rate of aftershock activity

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The Gutenberg-Richter formula on the magnitude-frequency distribution of earthquakes and the modified Omori formula for the decay of aftershock activity have been used in a lot of statistical analyses of seismicity and now seem to have established their universality and utility. The Omori formula was proposed more than 110 years ago and 60 years have passed since the formula was revised by Utsu (1957). Since that time when these formulas were proposed the observation network of seismic activity has improved remarkably. Our motivation to perform this study on the decay of aftershock activity was to examine the universality of the modified Omori formula in detail using data obtained by the seismic network in recent years. We found out before that the parameters in the modified Omori formula change depending on the threshold magnitude Mth of earthquakes used in the analysis (Hosono and Yoshida, 2002). Further, at the Joint Meeting in the last year, we reported that the decay rate. depends on the depth, having investigated aftershock activities for the 2000 Tottori-ken Seibu earthquake, the 2003 northern Miyagi earthquake and the 2000 Niigata-ken Chuetsu earthquake, Our finding was that the p-value in the modified Omori law is smallest for aftershocks in the medium-depth range indicating that shallow and deep aftershocks decreases relatively rapidly. It was also pointed out that the depth range for which the p-value of the aftershocks is the smallest almost corresponds to the seismogenic zone in the background activity in those areas. That study, however, was based on the analysis using only ten-day data of aftershock activities just after the main shocks owing to the contamination of many second aftershocks associated to an M5.9 shock that occurred about two weeks after the Niigata-ken Chuetsu earthquake. In this paper we report results of our new study on the depth dependence of the decay rate as well as its Mth dependence based on the data of the aftershock activity of the Niigata-ken Chuetsu earthquake for a longer time period. By examining decay of the activity in each of the zone of 5km depth range using aftershocks with magnitude 1.5 or larger for which almost all of them are estimated to have been detected, we have found that the decay rate is the smallest for the aftershock activity in the depth range in the mediate-depth range, when the seismogenic region is divided into shallow, intermediate and deep layers. We also discovered that the decay rate changes with Mth: The larger the Mth, the larger the deay rate. This result supports our previous study (Hosono and Yoshida, 2002). We expect our understanding about the mechanism how the aftershock activity is related to the physical state and material of the seismogenic field and the process how the stress in the focal region is relaxed will be deepend by scrutinizing implications of the dependence of the decay rate on the depth and Mth.