Seismicity cycle of inland active faults

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It is known from trench excavation survey of faults that a large earthquake which rupture the whole brittle fracture zone (earthquake occurrence zone) of the crust occurs repeatedly along the exposed weak planes, namely active fault [e.g. Ohnaka et al., 2002]. For active inland faults, after the occurrence of a large earthquake, the aftershock period when the seismicity is high continues from several to dozens of years [Watanabe, 1989]. In the 1891 Nobi Earthquake area, it is known that aftershock is still continuing more than a hundred years later. Aftershock activity fits very well to the Omori formula [Omori, 1894] which describes the aftershock occurrence in time [e.g. Yamashita, 1987]. Following the high level of aftershock activity, time within the earthquake cycle proceeds toward the next earthquake and there is a different phase of seismic activity [Toda, 2002].

Generally, the cycle of the large earthquakes on inland active faults is very long, tens of thousands of years to millions of years, and, there is a large variation in the duration of the period of a cycle between various faults. Furthermore, during the observation period of modern seismology which is about a hundred years, the observational result is available only for a small portion of an entire cycle, except faults with extremely short recurrence time. Although aftershock activity declines rapidly just after the mainshock, the rate of decay becomes very small and it becomes difficult to distinguish the decay rate from the steady activity after dozens of years have elapsed. That is, the length of time for which aftershock activity continues is not clearly determined, and in many cases, the period of aftershocks is equivalent to the observation period in modern seismology. Therefore, it is difficult to recognize how the seismic activity changes during the different portions of the earthquake cycle.

On the other hand, there are many active faults which are in different stages of their earthquake cycles. The geological fault information can be used to estimate what stage of the earthquake cycle the fault now belongs to. By combining these informations for many different faults, we can observe the seismic activity through many stages of the earthquake cycle. By clarifying the seismicity cycle over a long period, it can be expected to know whether the present stage is consistent with the cycle tendency or not. This contributes to earthquake prediction research greatly.

The hypocenters of the present seismic activity and the geological information from active fault investigation can be used together to study the changes of seismicity as related to the earthquake cycle. Although there is large variation in the scale and recurrence time of a fault, we develop corrections for these factors, and a clear correlation is recognized between the lapsed rate from a large earthquake and the present seismic activity. The rates of the seismicity show decay that lasts for almost the entire earthquake cycle. Since this decay follows the modified Omori formula, it can be thought the aftershock decay lasts for almost the entire earthquake cycle of hundreds to thousands years. Using our methodology, we can identify how the present seismicity fits in the earthquake cycle.