

Can felt reports of historical documents be used to estimate the source of large earthquakes? - Evaluation of applicability to historical large earthquakes -

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Can felt reports of historical documents be used to estimate the source of large earthquakes? Before establishing a new methodology, we show that the source area of recent three large earthquakes (2004 Niigata-Ken Chuetsu, 2008 Iwate-Miyagi, and 2011 Fukushima-Hamadori earthquakes) can be imaged from the spatial distribution of felt reports by using the JMA seismic intensity database. Our preliminary results imply the possibility that the large earthquake source can be constrained from spatial and temporal distribution of felt reports.

For the case of the 2004 and 2008 earthquakes, number of aftershocks with felt reports decreases with increasing distances at epicentral distances <100 km from the mainshock, while they fluctuate at epicentral distances >100 km, probably due to site condition and/or attenuation structure. This indicates that the effects of site amplification near surface and heterogeneous attenuation structure should be properly taken into consideration to estimate source of historical earthquakes. For the case of the 2011 earthquake, the number of aftershocks with felt reports fluctuated even at epicentral distances <100 km from the mainshock, because of the aftershocks following the 2011 Tohoku-oki earthquake. The areas imaged from the number of felt reports were well concordant with aftershock area following these mainshocks even after thinning out the observation stations as long as the station coverage was retained. In Japan, abundant historical literature during over 1,000 years is preserved; these have been used for estimating a source of a historical large earthquake (e.g., Usami *et al.*, 2013) and for revealing recurrences of great interplate earthquakes along the Nankai Trough (e.g., Ishibashi and Satake, 1998). Sources of historical large earthquakes have been traditionally estimated from seismic intensity distribution on the basis of damage for building structures and casualties recorded in historical literature. However, the damage was not necessarily caused by a ground shaking but also tsunami, massive fire and/or landslide. In addition, the distribution of building damage is strongly controlled by the population density and elapsed years since constructed. Thus, the estimated source of a historical large earthquake is possibly biased to a densely populated area.

In some historical literature, felt reports without any damage are also documented as well as damage description from major earthquakes. Most of historical documents only described 'earthquake with felt' as well as the date and time, whereas some of them particularly recorded the number of earthquakes with felt in each day with the intensity of ground shaking. On the basis of felt reports, it has been revealed that the seismicity rate increased in the central and northern parts of the Kinki district before and after the great Nankai earthquakes (Oike, 1996) and that the seismic quiescence possibly happened preceding to the 1861 Miyagi-oki earthquake (Matsu'ura and Tsuji, 2010). However, felt reports were not fully utilized except for several previous studies (e.g., Matsui and Oike, 1997; Satake, 2002).

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