Recent destructive inland earthquakes off major active faults: Implications for future updates of the seismic hazard map in Japan

Shinji Toda
Disaster Prevention Research Institute, Kyoto University, Japan

Abstract

Several recent large inland earthquakes in Japan since the 1995 Kobe earthquake have struck the lower probability areas mapped by the Earthquake Research Committee (ERC) of the Headquarters for Earthquake Research Promotion in 2005. Here we seek the reason why M6-7 class inland earthquakes occurred more frequently than ERC forecasted revisiting the emergence rate of tectonic surface ruptures in the past ~85 years. The most of the M≥6.5 shallow inland earthquakes have been believed to be accompanied with tectonic surface ruptures. Together with the characteristic earthquake concept, the empirical equation between Mjma and L have been widely used to estimate M when evaluating the seismic potential of an active fault. However, some of the reported surface breaks were extremely short relative to their source faults and amount of slip was faint, which do not allow us to retrospectively estimate sizes of the earthquakes and cannot be saved as a distinctive geologic record. From such a backdrop, here we re-examined the surface rupturing earthquakes since 1923 when JMA official catalog starts. We first selected all the earthquakes with Mjma ≥ 6.5 and shallower than 30 km in inland area since 1923. We then picked up the surface rupturing earthquakes documented by published papers, and categorized them into three, Rank 1, Rank 2, and Rank 3, depending on how much the rupture represented dimension of the source fault at the Earth's surface. We counted the number of Rank 1 ruptures which lengths are longer than 60% of the source fault and found five out of 30 M≥ 6.5 earthquakes, and four out of 10 M≥7.0 earthquakes produced the Rank 1 ruptures. In other words, only 17% of M≥6.5 and 40% of M≥7.0 shallow earthquakes left the surface breaks which correspond to their source fault dimension. Since most of active faults in Japan are not maturely developed, we would simply regard the accumulated landform produced by the frequent surface ruptures as a distinctive active fault. We thus speculate that the number of potential destructive earthquakes of M6-7 estimated from the major active faults would be clearly underestimated. For the future updates of the probabilistic map, we may need to add these deficit of the M6-7 size shocks considering all late Quaternary deformation off the major active faults.