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Magnitude and fault location of M7 class earthquakes in Akita inferred by seismic intensity inversion analysis

Katsuhisa Kanda[1*], Masayuki Takemura[1]

[1]Kobori Research Complex

The differences in ground motion according to fault rupture types and magnitude have been discussed since the occurrence of the 1995 Hyogoken-Nanbu earthquake. We have analyzed seismic intensity data and reexamined magnitude and location of inland crustal earthquakes considering fault rupture types.
The 1914/3/15 Akita Senpoku earthquake which was a subsurface rupture type event, was estimated to be M7.1 by Utsu(1982) and this magnitude has been commonly used since then. The 1896/8/31 Riku earthquake which was a surface rupture type event, occurred in the adjacent area and its magnitude (M7.2) differs little. However, its actual damage was comparatively larger than that of the Akita-Senpoku earthquake. The seismic intensity inversion analysis [Kanda et al.(2003)] was carried out aiming at clarifying magnitude and source location of these two earthquakes.
At first, we analyzed recent measured intensity data of shallow crustal earthquakes observed in Akita prefecture to obtain attenuation relationship of seismic intensity. We also evaluated local site factor, so-called 'relative seismic intensity', which was defined as difference between intensities evaluated from the attenuation relationship and observed. It was spatially interpolated based on the surface soil amplification factor [Wakamatsu and Matsuoka (2008)].
Since the source characteristics of the Akita Senpoku earthquake was not known for certain, we estimated the most appropriate fault model based on the result of a grid search method using intensity data and other existing research works such as hypocenter distribution of micro earthquakes and S-wave velocity perturbations [Okada et al.(2009)] at first. Meanwhile, the Riku earthquake left apparent surface faults and the location of faulting was already identified. And we implemented seismic intensity inversion analysis to obtain areas radiating short-period seismic waves and appropriate magnitude of both events.
The seismic intensity inversion analysis for the Akita Senpoku earthquake assuming an east-dipping fault model (depth: 6-13km) indicated that the short-period radiation zone was located in the north and deep area. We found that there was a low S-wave velocity zone in the lower crust beneath it. The appropriate magnitude with least evaluation error was estimated as M=6.5~6.6. Magnitude was also estimated from area of seismic intensity five or more using empirical relationship [Muramatsu(1969)] to verify the intensity inversion result. It resulted in M6.6~6.7. It may be concluded that magnitude of the Akita Senpoku earthquake was less than 7.0 at most even if considering estimation error.
The seismic intensity inversion analysis of the Riku earthquake was carried out assuming two conjugate fault models along Mahiru mountains eastern margin and Yokote basin eastern margin. The most appropriate magnitude was estimated as M7.2, which is consistent with that by Utsu(1982). It is indicated that the Riku earthquake was lager than the Akita Senpoku to 0.5 in magnitude. The short-period radiation zone of the Roku earthquake was located in shallow zone near surface fault. It shows opposite features compared to the Akita Senpoku earthquake which has no surface fault.

Keywords: seismic intensity inversion, Akita Senpoku earhquake, Riku earthquake, surface fault, magnitude, earthquake damage