Fault model of the 1918 Ohmachi Earthquake revisited

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The central part of the Itoigawa-Shizuoka Tectonic Line (ISTL) is now considered to be an area with one of the highest seismic risk in the Japanese inland. It is important to investigate seismic activity in such an area in order to prepare for large earthquakes in the future. Along ISTL, the 1918 Omachi earthquake is the only disastrous earthquake whose scientific documentation is available.

The Omachi earthquake was a dual-shock event occurred on November 11, 1918. M6.1 and M6.5 events occurred at 2:59am and 4:04pm, respectively. There is a leveling line running in the N-S direction across the focal region. A revision survey of leveling was conducted after the earthquake, and a maximum of 20cm uplift was found. Tada and Hashimoto (1988) analyzed the leveling data and deduced an eastward dipping fault, while Kawauchi (2000) inferred a westward dipping fault based on the same data. In order to solve for the controversy, I re-examine the leveling data, referring other data sources such as structural data as well.

First, the leveling data themselves are carefully inspected again. There was a coseismic relative height change of 75mm between benchmarks 2895 and 2896, located about 10km north of the focal region. However, following surveys revealed the relative height returned to the preseismic value afterwards. So I checked the leveling field note and found an artificial change of readings. After removing the artificial changes, the large change in leveling data disappeared. Thus I conclude that the large relative height change between 2895 and 2896 was not real.

I conducted a geodetic inversion analysis to estimate a fault model of the Omachi earthquake. First I assumed a westward dipping fault as suggested by Kawauchi (2000). But the result was not successful in reproducing the large uplift along the leveling route and the surface faulting found in the southwestern Omachi. Next, I assumed a fault parallel to ISTL, changing the dip angle by every 10 degrees, and applying slip direction consistent with the direction of the principal compression. The estimated fault model is dipping eastward with a dip angle of 30 degree, just beneath the central Omachi. This fault plane roughly coincide with a structural boundary between the Paleozoic-Mesozoic formation and the basement obtained by Okubo et al. (2000). This fault model predicts a maximum uplift of about 35cm in the mountain southwest of Omachi, and an eastward tilting around the area of surface faulting, consistent with the observation.

There is an area of remarkable E-W shortening east of ISTL near Omachi as revealed by Tada and Hashimoto (1990) based on triangulation data. Recent GPS observations confirmed a similar deformation pattern (Sagiya et al., 2002). This deformation can be interpreted as a result of surface folding caused by a steady slip on the deeper extension of ISTL. The Omachi earthquake can be interpreted to have released a stress accumulated by the deep fault slip by rupturing a weak part of the crust. The uplift of the Chikuma Mountains east of ISTL can be ascribed to the deep fault slip, while the uplift of the Northern Japan Alps needs another explanation.