

Past large earthquakes beneath metropolitan Tokyo: Issues for estimation of occurrence probability and disaster

SATAKE, Kenji^{1*} ; ISHIBE, Takeo¹ ; MURAGISHI, Jun¹

¹Earthquake Research Institute, the University of Tokyo

Two types of large earthquakes, great interplate ($M \sim 8$) earthquakes along Sagami Trough and $M \sim 7$ earthquakes beneath southern Kanto region, have caused damage in metropolitan Tokyo and are expected to occur in the future. The 1923 Taisho Kanto earthquake (September 1, $M 7.9$) and the 1703 Genroku Kanto earthquake (December 31, $M 8.2$) are the first type, and the typical example of the second type is the 1855 Ansei Edo earthquake (November 11, $M 7.0$).

The Cabinet office and the Earthquake Research Committee of the Japanese government recently re-examined the source area of the interplate earthquake along Sagami Trough, estimated that the maximum possible size would be $M 8.6$, and that the 1703 earthquake may be closer to the maximum size. Previous Kanto earthquakes have not been well studied; recent studies of tsunami deposits (Shimazaki *et al.*, 2011, JGR) concluded that the 1293 earthquake (May 20) was the Kanto earthquake along Sagami Trough. The 1495 earthquake (September 3) has been considered as a fake earthquake, possibly confused with the 1498 Meio earthquake along Nankai Trough, but Kaneko (2012, Ito-shi Kenkyu) proposed that the 1495 earthquake was another interplate earthquake along Sagami trough. Studies of historical documents and tsunami deposits have revealed the recurrence of Kanto earthquakes. Details of each event, such as the source area or possibility of simultaneous rupture on Koze-Matsuda fault, need to be studied to clarify the diversity of recurrent interplate earthquakes.

A hypothetical earthquake beneath Tokyo at the deeper plate interface, the northern Tokyo Bay earthquake, had been considered for disaster estimation of metropolitan Tokyo. Recent damage estimation by the Cabinet Office (2013), however, assumed an earthquake in the Philippine Sea Plate, which would cause similar seismic intensity with the 1855 Ansei Edo earthquake. The hypocenter of the 1855 earthquake has been studied on the basis of seismic intensity and damage distribution from historical literature, and various estimates ranging from a shallow crustal source to 100 km deep source within the Pacific Plate have been proposed. The seismic intensity distribution in Kanto region is strongly influenced on both deep and shallow subsurface seismic velocity structures, hence quantitative comparison with recent earthquakes or simulation on three-dimensional velocity structure would be necessary to accurately estimate the 1855 hypocenter.

The Earthquake Research Committee (2004) estimated the 30-year probability of $M \sim 7$ earthquake in southern Kanto region as 70 %, on the basis of five earthquakes since 1885 and the Poisson process. The five events are: 1894 Meiji Tokyo earthquake, 1895 and 1921 Ibraki earthquakes, 1922 Uraga channel earthquake, and 1987 eastern Chiba earthquake. Among them, at least three (1921, 1922 and 1987) occurred in the Philippine Sea Plate, and one (1895) occurred in the Pacific Plate (Ishibe *et al.*, 2012, Coord. Comm. Earthquake Prediction). For more accurate estimation of future probability, studies of older earthquakes from historical records and estimation of their epicenter, depth and earthquake types are required.

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