

Classification of Magnitude 7 Earthquakes in Tokyo Metropolitan Area since 1885

MUROTANI, Satoko^{1*}, ISHIBE, Takeo¹, SATAKE, Kenji¹, SHIMAZAKI, Kunihiko¹, NAKAGAWA, Shigeki¹, SAKAI, Shin'ichi¹, HIRATA, Naoshi¹, NISHIYAMA, Akihito¹

¹ERI, the Univ. of Tokyo

We estimated the source regions of five earthquakes which occurred in southern Kanto region since 1885 (i.e., the 1894 Meiji Tokyo, 1895 and 1921 Ibaraki-Ken Nambu, 1922 Uruga channel and 1987 Chiba-Ken Toho-Oki earthquakes) and classified them into intraplate or interplate earthquakes by analyzing collected data (Ishibe et al., 2009a, 2009b; Murotani et al., 2011) and comparing with seismic velocity model (Nakagawa et al., 2011). The 1894 Meiji Tokyo Earthquake was a slab earthquake within the Philippine Sea plate (PHS) or an interplate earthquake between PHS and Pacific plate (PAC). The 1895 Ibaraki-Ken Nambu Earthquake was a slab earthquake within PAC. The 1921 Ibaraki-Ken Nambu, 1922 Uruga Channel and 1987 Chiba-Ken Toho-Oki Earthquakes were slab earthquakes within PHS with strike-slip fault mechanisms.

Significant changes in both hypocentral locations and focal mechanisms have been observed after the 2011 off the Pacific coast of Tohoku earthquake (e.g., Hirose et al., 2011; Kato et al., 2011). The same situation would be expected for the Kanto earthquakes and understanding the spatio-temporal changes in stress field during a seismic cycle might be a key to time-dependent evaluation of earthquake occurrence probability. For example, the association between the 1923 Kanto Earthquake and two preceding slab earthquakes within PHS is interesting (e.g., Nakajima et al., 2011).

Probability of large earthquakes with magnitude (M) ~ 7 during the next 30 years was estimated to be 70 % based on the above five earthquakes by the Earthquake Research Committee (2004). However, types of these earthquakes are not well known due to low quality of data. We tried to classify these earthquakes into intraplate or interplate earthquakes.

The focal depths of the 1894 Meiji Tokyo earthquake ($M7.0$; Utsu, 1979) from previous studies are variable due to the differences of s-p times. Our study also shows similar variation (7-10 s) obtained from waveforms at Hongo, the University of Tokyo. Seismic intensity map based on the Central Meteorological Observatory (1895) and Hagiwara (1972) indicates circular pattern. However, the seismic intensity distribution of the earthquake of October, 7, 1894 occurred in southern Kanto indicates isoseismals extended along the PAC. In Hongo, the s-p times of the Meiji Tokyo earthquake and earthquake of October, 7 are about 7.0 s and 17.0 s, respectively. This suggests that the discussion on the focal depth is possible based on seismic intensity distribution and that the Meiji Tokyo earthquake was not a slab earthquake within PAC.

The focal depth of the 1895 Ibaraki-Ken Nambu earthquake ($M7.2$) was estimated to be ~ 80 km using s-p time at Tokyo (11.3 s) assuming epicenter by Utsu (1979). The s-p times read in this study are about 11 s and are consistent with the report of Omori (1899) although they show some variations.

The focal depth of the 1921 Ibaraki-Ken Nambu earthquake ($M7.0$) was estimated to be around 53 km using s-p times of seismograms or JMA reports. Seismic intensity distribution supports this result; anomalous seismic intensity distribution characterizing the PAC slab earthquakes is not recognized. Furthermore, initial motion focal mechanisms using modified HASH algorithm (Hardebeck and Shearer, 2002) are strike-slip types, even if the uncertainty of hypocenter locations is taken into account.

The hypocenter of the 1922 Uruga Channel earthquake was estimated in the southwestern Chiba at a depth of around 53 km from s-p times obtained from seismograms or JMA reports. The initial motions indicate either strike-slip or normal fault type focal mechanism if the hypocenter uncertainty is taken into consideration. The circular isoseismals suggests that this earthquake was not a slab earthquake within PAC.

Keywords: Tokyo metropolitan earthquake, Classification, intraplate earthquake