

Was the 1611 Keicho earthquake a giant interplate event like the 2011 Tohoku earthquake?

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After the 2011 Tohoku earthquake (M9.0), the 1611 Keicho earthquake along the Japan trench has been regarded as a giant interplate event. In this study, from the examination of reliability of the historical records about the 1611 event and comparison between the impact on Kanto by the 2011 and 1611 events, we consider that the 1611 earthquake was not a giant interplate event but a tsunami/outer-rise earthquake.

From the historical documents, the Dec. 2nd, 1611 Keicho earthquake generated large tsunami on the Pacific Coasts of Tohoku and Hokkaido while this event caused no seismic damage in Tohoku and Kanto. Since the 1896 tsunami earthquake (M8.1) and 1933 outer-rise earthquake (M8.1) had similar features, the 1611 event had been regarded as an M~8 tsunami/outer-rise earthquake (Hatori, 1975; Aida, 1977; Watanabe, 1998). After the 2011 Tohoku earthquake, however, some studies claimed that the 1611 earthquake was probably a giant event because the tsunami heights and inundation areas estimated from the historical documents (e.g. Hatori, 1975; Tsuji et al., 2011; Ebina and Imai, 2014) are comparable to (or larger than) those of the 2011 event (e.g. Ebina, 2014; Iwamoto, 2013). Following this claim, tsunami researchers attempted to make fault models to reproduce the 1611 tsunami by the tsunami numerical simulation. Imai et al. (2015) proposed two fault models. One is a giant interplate event (fault size: 400km*200km, Mw8.7), another is a model (Mw8.4) of simultaneous occurrence of a great interplate event (fault size: 400km*150km) and a great outer-rise event (fault size: 400km*50km). Fukuhara and Tanioka (2017) considered that the 1611 event was a giant tsunami earthquake (fault size: 250km*50km, the maximum slip: 80m, Mw9.0).

In this study, however, we considered that the 1611 Keicho earthquake was not a giant interplate event but a M~8 tsunami/outer-rise earthquake from the following reasons: (1) Reliability of the 1611 tsunami heights and inundation areas is not high because they are estimated from the historical records without examination of reliability. There are historians who dispute the 1611 giant earthquake based on the unreliable historical records (e.g. Kan' no, 2014; Sasaki, 2014; Saino, 2017); (2) Strong shaking by the 2011 mainshock caused severe damage in Kanto and aftershocks and induced events caused additional damage and successive shakings in this region for several weeks. Whereas, as for the 1611 earthquake, only two shakings in Edo (present Tokyo) are recorded in the court nobles' diaries and there is no record of the seismic damage in Kanto. From the primary historical documents, Ieyasu Tokugawa went hunting with hawks to the present Saitama Pref. and court nobles went sightseeing to environs of Edo on the next day of the 1611 event. Therefore, the 1611 earthquake was probably an event which didn't impact on Kanto, i.e. not a giant interplate event like the 2011 earthquake. M~8 interplate event in 1793 offshore present Miyagi Pref. caused minor seismic damage in Edo and its 2-days aftershocks shocked Edo more than 50 times (Usami et al. 2013); (3) Even if the 1611 earthquake was an M~9 tsunami event, ~80m slip on the large fault (250km*50km) should cause many aftershocks and widely induce earthquakes including M7-8 events. As mentioned above, however, there is no record about the successive earthquakes after the 1611 event; (4) No tsunami deposit by the 1611 event is discovered at the ruins in Sendai Plain excepting Taka-ose Ruin in the present Iwanuma City (Saino, 2017), while they are discovered on the Sanriku Coasts (e.g. Takada et al., 2016). In addition, they are not discovered at the Idagawa marsh in the present Fukushima Pref. (Kusumoto, et al. 2018). Therefore, 1611 tsunami probably didn't inundate deeply in the lowlands on the Pacific Coast in Miyagi and Fukushima Pref. Recently, Goto et al. (2019) reported that the

1611 tsunami deposits were not discovered at the Numano-hama of Sanriku Coast.

Keywords: 1611 Keicho earthquake, a giant interplate earthquake, reliability of historical records, primary historical documents, tsunami heights and inundation areas, tsunami traces