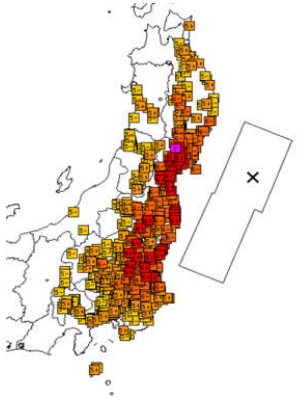
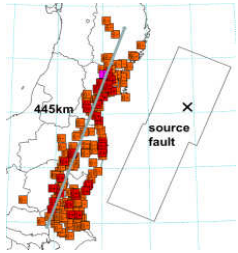
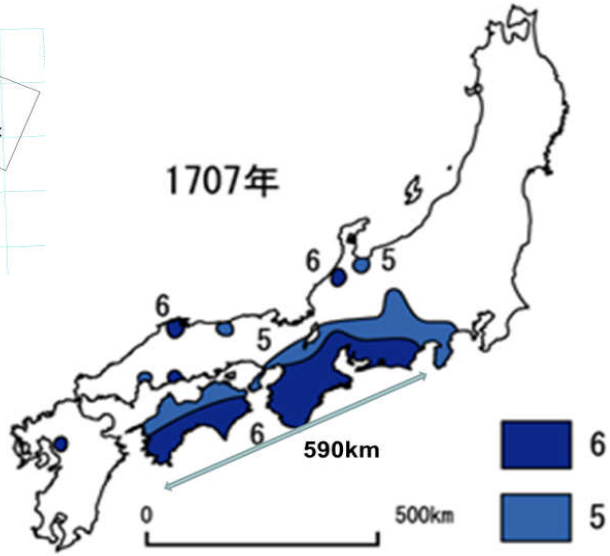
Re-evaluation of Mw of the 1707 Hoei earthquake

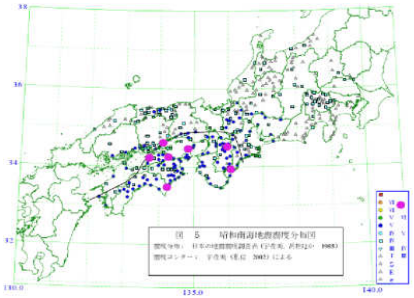
Yuzo Ishikawa : *Active Fault and Earthquake Research Center , AIST, 1-1-1 Higashi, Tsukuba, Ibaraki 305-8567, Japan*

Abstract
It was well known that the 1707 Hoei earthquake was the one of the largest event in Japan. The magnitude of the Hoei earthquake was estimated as M8.6 in the Science Table 2011 version, using the felt area and M8.8 or 8.9 by Usami(2003). It is a standard way for the historical events. But, the length of the source faults of the Hoei earthquake was very long as about 600km from Suruga bay to off Ashizuri peninsular (Aida, 1981a,b). It is longer than the one of 2011 East Japan event Mw9.0. It was thought that the magnitude of the Hoei earthquake was underestimated and it must be re-evaluated.
The formula of estimating the magnitude of historical events in and around Japan proposed by Muramatsu(1969) was commonly used. He gathered the intensity distribution of more than 10 events in and around Japan to get the empirical formula between the length of seismic intensity (JMA scale) 5 or 6 area to the magnitude. He got the good formula for magnitude range from 6 to 8.1. The limitation of the lack of data for large events was not regarded to estimate the magnitude of the Hoei earthquake, because there was no data of such large magnitude. Now we got the intensity distributions for large magnitude, ex 2003 Tokachi earthquake Mw8.0 and 3-11 earthquake Mw9.0. Finally, we estimated the magnitude of the 1707 Hoei earthquake using the length of the area of intensity 6 and the aftershock distribution of 3-11, The results is obtained that Mw 9.1 to 9.3 is suitable for the Hoei earthquake.

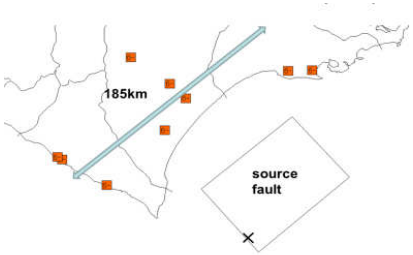






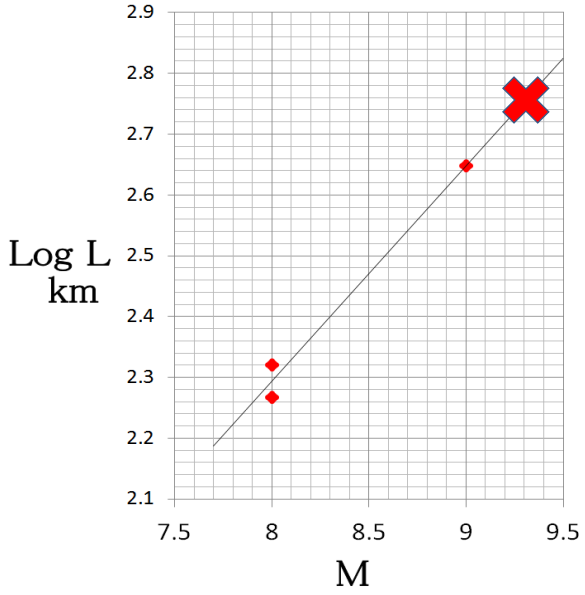


1946 Nankai M8.0
Length of Ijma 6 is 207km.



2003 Tokachi-oki M8.0
Ijma 6

Establishing the new empirical formula
The area of I5 is not suitable to estimate the magnitude, as its area was strongly affected by the volcanic distribution in the case of 3-11 quake. The length of the major axis of I6 area was used to estimate the magnitude. But, Muramatsu's formula (1969) of Intensity 5, 6 was not suitable for mega quakes, as it was driven using moderate intra quakes(M6 to 8.1). So, new formula for mega quake was obtained using 1946 Nankai M8.0, 2003 Tokachioki M8.0, and 2011 NE Japan M9.0 quakes.
Aditional information
Fujita(2003) found the historical document in Jeju, Korea reported that Jeju was attached by tsunami after the occurrence of 1707 Hoei earthquake. Aida's faults model(1981) of the 1707 Hoei earthquake Mw8.4 could not generate the tsunami which arrived at Jeju.



The Lenth of I6 of 1707 Hoei is 590km.
From the new empirical relation, M9.3
Was obatined.

$$M=2.78 \times \mathrm{Log}\ L_{(km)}+1.64$$

Mega quakes in 21c

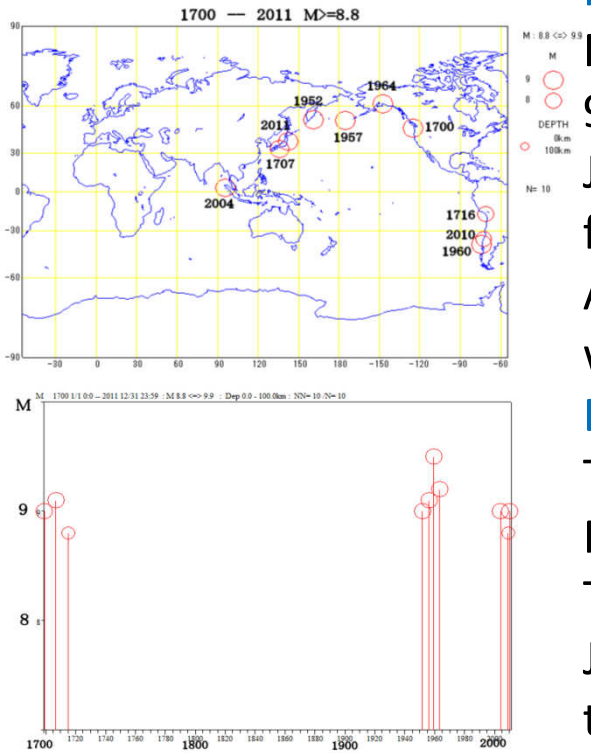
2004 Sumatra (Mw9.0)
2010 Middle Chile (Mw8.8)
2011 NE Japan (Mw9.0)

Mega quakes in 20c

1952 Kamchatka (Mw9.0)
1957 Andreanof, Aleutian (Mw9.1)
1960 Chile(Mw9.5)
1964 Alaska (Mw9.2)

Mega quakes around AD1700

1700 Jan. 26 Cascadia (M9.0)
1707 Oct. 28 Hoei (M～9.3)
1716 Feb, 06 Peru Trata(M8.8)



Upper: Epicenter distribution of mega quakes from 1700 to 2011.
Lower: magnitude time figure.

Results

Mw of the 1707 Hoei event was about 9.3 estimated by the major length of JMA Intensity 6, using new empirical formula.

A series of mega quakes occurred within 13 and 17 years.

Discussion

The number of samples to estimate Mw is very few.

The source fault of Hoei is near to Japanese island than 3-11. It may be that the area of I6 in SW Japan is some wider than in NE Japan.