Source processes of the 1936 and 1978 Miyagi-oki earthquakes from the tsunami waveform analysis

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On June 12, 1978, a large earthquake (M=7.4) occurred off the Pacific coast of Miyagi prefecture, northeastern Japan. The earthquake killed 28 persons and caused extensive damage in Miyagi prefecture. The previous large earthquake occurred in this region was the 1936 Miyagi-oki earthquake which also caused extensive damage. Therefore, a next large earthquake is expected in this region. It is important to estimate the slip distribution of both the 1978 and 1936 events in order to discuss a possible rupture area of the next event. Previously, we estimated the slip distribution of the 1978 Miyagi-oki event using the tsunami waveforms observed at 14 tide gauge stations along the Pacific coast of northeastern Japan. The largest slip of 1.3 m was found in the western (landward) part of the fault area. The total seismic moment of the 1978 event was estimated to be 1.7 X 10**20Nm (Mw=7.5). In this paper, we estimate the slip amount of the 1936 event using the tsunami waveforms observed at 3 tide gauges.

We use three tsunami waveforms observed at Hachinohe, Tsukihama, and Ishinomaki for this study. The detail bathymetry data near the tide gauges in 1936 are necessary to compute tsunami accurately. A detail bathymetry map of the Hachinohe port in 1936 was found in the Hachinohe Port and Airport Construction Office. The original tide gauge record at Hachinohe for the 1936 event was also found in the Hachinohe observatory of the JMA. The bathymetry near Tsukihama has little changed since 1936. The bathymetry near Ishinomaki in 1936 is constructed from the old map of the Ishinomaki City. The original tide gauge records at Tsukihama and Ishinomaki are not found. Therefore, the tsunami waveforms shown by Miyabe (1937) were used for those stations in this study.

The focal mechanism of the 1936 event was assumed to be the same as that of the 1978 event (strike=190, dip=20, rake=76). Two subfaults where larger slip amounts were estimated for the 1978 event was used in this study. We numerically compute the tsunami waveforms using the finite-difference computation. The grid size is basically 20 sec of arc (about 600m), but finer grids (4 sec of arc) are nested near the tide gauge stations.

The results show that the observed tsunami waveforms at three tide gauge stations are well explained by the computed waveforms from the main two subfaults of the 1978 event. It suggests that the 1978 and 1936 events may rupture the same plate interface. The total seismic moment of the 1936 Miyagi-oki earthquake is estimated to be 0.50 x 10**20 Nm (Mw 7.1) which is about 1/3 of the total seismic moment of the 1978 event. However, it will be necessary to include more tide gauge data in order to obtain the decisive conclusion.