2011年長野県北部の地震(*Mw* 6.2)の核形成過程
Nucleation Process of the 2011 Mw6.2 Northern Nagano Earthquake

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Introduction. Previous research.

An Mw6.2 inland earthquake occurred in northern Nagano region, central Japan, about 13 hours after the Mw9.0 Tohoku-oki megathrust earthquake. The regional seismic activity recorded in the Japan Meteorological Agency (JMA) catalog in the first hours following the megathrust event was highly incomplete, thus not allowing a detailed analysis of triggering mechanisms. By applying a Matched Filter Technique (MFT) to the continuous Hi-net (NIED) waveform data, Shimojo et al. (2014) revealed an immediate post-Tohoku seismicity activation in an area located about 10 km south of the Mw6.2 Northern Nagano source region. They also detected a few foreshocks close to the hypocenter of the Mw6.2 mainshock, within one hour before the occurrence of the moderate-size event. However, the physical processes that led to the occurrence of the Mw6.2 earthquake remained unclear. In this study we take advantage of the data recorded by a dense temporary seismic network operated by NIED from 2008 to 2012 to reveal with an unprecedented resolution the nucleation process that culminated with the occurrence of the Northern Nagano earthquake.

Data and Method

We use the waveform data of the NIED “Hizumi” temporary network, with station spacing of about 5 km or less in the study area. The data recorded by the permanent Hi-net stations (spacing of about 20 km) complements that of the dense regional network. We have first picked P- and S-wave arrivals of earthquakes on the continuous seismograms and use the pick data to locate the events. The earthquakes were then relocated using the tomoDD software (Zhang and Thurber, 2003) and a 3D velocity structure in the region (Sekiguchi et al., 2013). The newly located earthquakes were further used as MFT templates to search for new events within the 13-hour time interval, in the hypocentral region of the Mw6.2 earthquake.

Results and Discussion

We have detected a total of 286 earthquakes in the source region of the Mw6.2 event. The earthquakes are relatively small, with magnitudes less than 3.0, and distribute within two spatially distinct clusters: one of these clusters was located close to the hypocenter of the Mw 6.2 event (“West” area), the other about 5 km to the east (“East” area).

In the “East” the seismicity starts within one hour after the Tohoku-oki earthquake. The events occur off the Mw6.2 fault and expand with time from shallow towards deep locations. In the “West” the seismicity starts immediately after the passage of surface waves excited by a moderate earthquake in the Tohoku-oki aftershock area, which occurred 21 minutes after the Mw9.0 megathrust; the majority of these events distribute along the fault line of the Mw6.2 mainshock. The seismicity (in the “West”) that occurred in the immediate vicinity of the Mw6.2 hypocenter was activated about 3 hours before the mainshock and continued until its occurrence.

In both “West” and “East” regions the seismicity activation pattern shows correlation with the amplitude of the low-frequency waveforms observed at a nearby Hi-net seismic station. Such a

correlation may indicate that dynamic stress changes caused by the aftershocks of the Tohoku-oki megathrust event effect the seismicity in both areas. The triggering “sensitivity” might be enhanced by excitation and circulation of fluids, which are abundant both within the shallow thick sediment as well as the lower crust of the Nagano basin, as revealed by high-resolution tomography studies (Sekiguchi et al., 2013).

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