

The 3-stage earthquake generation process observed during 3 months before the 2011 Tohoku earthquake (2)

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1. none

1 Introduction

Various phenomena were observed before the 2011 Tohoku earthquake. As for the broad band seismic network; F-net, its availability was degraded from the end of December, 2010 to mid-January, 2011, then from mid-February to the beginning of March, and finally the main shock occurred on March 11, 2011. So, measuring results such as of GNSS etc. are added to further check the degraded periods of the F-net.

2 Analysis

It seems that the period of approximately 3 months before the earthquake was consisted of 3 stages indicated below.

First stage

Period: mid-December, 2010 to around January 28, 2011.

Analysis: Accumulation of strain in the continental plate reached upper limit in the Tohoku and Chubu regions. The continental plate stopped westward motion. The Pacific plate also stopped its advancement. Possibly as a result of such situation, the wide area in Japan showed abnormal situations.

Observed events:

- The Tohoku region which had been moving to west for years stopped westward motion on around January 28, 2011. On January 27, the westward motion of the ocean plate, i.e. the Pacific plate also stopped. It stopped movement till the main shock. The following situation was observed in around 1.5 months prior to this change.
- Abnormal values were observed in groundwater at the coastal area of Iwate prefecture from mid-December, 2010. On December 22, earthquake of M 7.4 occurred near Chichijima island. In January 2011, many low frequency earthquakes occurred directly under Hakoneyama mountains.
- F-net increased number of data-missing observation points since the end of December 2010, and it became four on January 14, 2011. The 4 points are Sanriku Coast - South of Hokkaido (2 points) and Noto - Izu Islands (2 points).
- According to GNSS, the entire Japan moved southward on January 5, 2011, and wide areas of Japan moved westward on January 23.

Second stage

Period: Around February 29, 2011 to around March 2, 2011

Analysis: As a result of the first stage, restless increase of stresses by the Pacific plate could not be accepted any more by the continental crust.

Observed events:

- The land that stopped westward movement on around January 28, 2011, changed direction of the movement for 180 degrees from January 29.
- Slow slip was observed near the epicenter area from January 29. This movement continued till just before M7.3 earthquake of March 9.
- February 13 to the end of February, Earthquakes of M5 or greater occurred near the starting point of the main shock.

·From February 16 to March 2, there was an increase in malfunction of the F-net. The largest number was 4 stations on February 18th. These are composed of 2 regions; Sanriku Coast - South of Hokkaido (3 places) and Gifu Prefecture (1 place).

Third stage

Period: Around March 8, 2011 to the main shock on March 11, 2011.

Analysis: Slipping of the continental plate started, and it lead to the main shock.

Observed events:

- On March 8, eastward movement of the Tohoku region was recorded by GNSS.
- The Sanriku-oki earthquake (M7.3) occurred on March 9. The earthquakes with magnitude of 6 followed.
- On March 11, The main shock of the Tohoku earthquake occurred.

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