

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

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Introduction

At the subject earthquake, missing status of the data (the continuous waveform images) for the F-net broadband seismic network deteriorated from late December 2010 to early May 2011 [1].

So we investigated the occurrence process of the earthquake and showed that about 3 months before occurrence was consisted of the following three stages [2].

The first stage (mid-December 2010 to around January 28, 2011) Long term accumulation of strain in the continental plate reached the limit. The continental plate stopped westward motion in the Tohoku region around January 28, 2011. Around the same time, the Pacific plate which is the oceanic plate also stopped westward motion. About 1.5 months ahead of this, movements not normally seen occurred in the wide area of the Japanese archipelago, mainly in the Tohoku and Chubu (or Central) regions.

The second stage (around January 29 to around March 2, 2011) The continental plate which stopped westward movement reversed the direction of movement at this stage. And it increased the repulsive force to the Pacific plate rather than the dependent movement so far. This increased the shear force at the plate boundary, resulting in active seismic activity such as slow slip near the epicenter area. There was also a change in land near the epicenter.

The third stage (around March 9 to March 11, 2011) A series of seismic activities occurred beginning the Sanriku-Oki earthquake M7.3 on March 9, and reached the M9.0 earthquake on March 11. Note: In the previous report, the start date was set to "around March 8". After several studies, it is now changed to "around March 9".

Investigation

As a further study, we examined the date of occurrence of the events occurring in January 2011 and obtained the following results.

- Unusual behaviors of geomagnetic diurnal variations were observed on January 4 to 14 at Esashi in Iwate Prefecture.

- A monthly survey on low frequency earthquakes in the underground of Mt. Hakone for more than 10 years shows maximum number of occurrences in January 2011. Further examination shows that the earthquakes occurred from January 1 to 31, further they occurred many from January 2 to 20 with a peak on January 10.

- Number of station with missing data in F-net increased from December 22, 2010 to January 18, 2011, and it became 4 stations on January 14, which is the maximum. The stations with missing data were two areas, i.e., the one near the epicenter area (Yamagata in Iwate prefecture (IYG) and Sapporo (HSS)) and the one in the Chubu region. Missing status of those near the epicenter remained after January. As for those in the Chubu region, Aogashima (AOG) missed the data from January 3 to 18, and Wajima (WJM) missed the data around the same time. They returned to normal after these periods.

To summarize above, unusual behaviors of geomagnetic diurnal variations were observed in the Tohoku region for the period of January 4 to 14, 2011. Vibrations were also observed in Wajima, Mt. Hakone and Aogashima around January 3 to 18 with the peak around January 10 to 14.

Discussion

It is necessary to further investigate unusual behaviors of geomagnetic diurnal variations, for it is possibly related to the process of earthquake generation.

On December 22, 2010, a M7.4 earthquake occurred near Chichijima. The movement of the Pacific plate observed at GNSS station in Chichijima accelerated westward then slowed down, and finally stopped on January 27. Therefore the relevance is inferred.

With a very long period (20 to 150 days) analysis on GNSS data, there were movements of crust in a wide area throughout Japan on January 5. Also on January 23, there were another movements. It is necessary to study relationship with this movement.

References

[1] Yoshiki Sue, 2013, JpGU SSS30-P01.

[2] Yoshiki Sue, 2017, JpGU SSS04-P08.

Note: Please refer to the above documents for information in this text.

Keywords: the 2011 Tohoku earthquake, F-net, GNSS

図1. 2011年1月の異常出現場所

2011年1月14日付けのF-netの連続波形画像マップ (Daily plot) に地磁気異常の江刺と低周波地震の箱根山を記入したもの。異常は中部地方以北で発生している。

Figure 1. Abnormal location in January 2011

On the map of F-net's waveform images (Daily plot) dated January 14, 2011, Esashi for unusual behaviors of geomagnetic diurnal variations and Mt. Hakone for low frequency earthquakes are added. Abnormality occurred only in the Chubu (or Central) region and north.

