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Seismic anisotropy in the southern part of Tohoku region

IIDAKA, Takashi[1*], OBARA, Kazushige[1]

[1]Earthquake Research Institute, University of Tokyo

Introduction

The 2011 off the Pacific coast of Tohoku earthquake (the 2011 Tohoku earthquake) is a huge earthquake with the magnitude of 9.0. The earthquake occurred on March 11, 2011, in off shore of Tohoku region. It was the largest earthquake after the modern seismic network systems was established. Several fault models of the 2011 Tohoku earthquake have been presented. The effect of the earthquake seems to be large. The seismicity pattern in the eastern part of Japan changed after the 2011 Tohoku earthquake.

The area, northern part of Ibaraki prefecture and southern part of Fukushima prefecture, is one of the places that the seismicity changed. In the region, background seismicity was very low before the 2011 Tohoku earthquake. It is very obvious the low seismicity region was activated by the great earthquake. Most of the focal mechanisms of the earthquakes are normal fault type after the 2011 Tohoku earthquake. The stress filed of the Japan has been reported (e.g., Kaneshima et al., 1990). The maximum stress direction of the area is E-W direction. It was parallel to the subduction direction of the Pacific plate. It has been considered that the stress field is caused by the subducting Pacific plate.

In the northern Ibaraki and southern Fukushima areas, the seismic activity increased abruptly after the 2011 Tohoku earthquake. The mechanisms of the earthquakes are normal fault type with the tension axis of N-W direction. It is inconsistent with the stress field in this area. It is expected that the stress field of Japan should be changed because of the large displacement caused by the huge earthquake.

The shear-wave splitting is one of the good tools to know the stress field. The cause of the shear-wave splitting in the crust is related to the alignment of crack opening. It is estimated that the direction of the alignment of opening cracks is parallel to the maximum stress axis. The polarization direction should parallel to the direction of maximum stress axis. This method is useful to know the stress field where the large earthquake cannot be observed. In this study, the polarization direction is researched between the before and after the 2011 Tohoku earthquake. The lateral variation of the pattern of the polarization direction was researched. The change of the stress field was estimated by the use of shear-wave splitting method.

DATA

We set up two data sets. One is the data of the earthquakes before the March 11 2011. The earthquakes with the period from January 1, 2001 to March 10, 2011 are used at the data set of before earthquakes (dataset 1). The other is the data with the earthquakes which occurred from June 1, 2011 to Sep. 30, 2011 (dataset 2).

Results

The shear-wave splitting results of the southern part of Tohoku region suggested clear lateral variation. The shear-wave splitting in the northern part of Ibaraki prefecture and southern part of Fukushima prefecture shows the N-S polarization direction. On the other hand, the seismic stations, which are located at the western part of the research area suggested the E-W polarization direction. The E-W polarization direction is consistent that the expected stress field in this area. However, the data at the area of the northern part of Ibaraki prefecture and southern part of Fukushima prefecture indicated that this area is characterized by the local stress field.

The shear-wave splitting of the data of after the 2011 Tohoku earthquake indicated that the polarization azimuths are almost N-S direction. The polarization direction was also consistent with that of before the earthquakes. It is suggested that the stress field in this research area was not changed by the 2011 Tohoku earthquake.

Keywords: Crust, Anisotropy, Tohoku