Measurement of seismic velocity anisotropy in the Tohoku region using shear wave splitting analysis (5) - Possible change associated with the Tohoku-Oki earthquake

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The 2011 Tohoku-Oki earthquake caused changes in seismic activity. The cause of this change is thought to be changes in stress and fluid pressure. The stress and fluid pressure changes may also affect the seismic wave velocity anisotropy. In this study, shear wave polarization anisotropy in the Tohoku region before and after the 2011 Tohoku-Oki earthquake was measured using shear wave splitting, in which shear wave splits into fast and slow shear waves when seismic waves pass through an anisotropic elastic medium in the crust. The method used was the Multiple Filter Automatic Splitting Technique (MFAST; Savage et al., 2010). In this method, by inputting the three components of the seismic waveform, the optimum filter is selected from 14 prepared filters.The orientation and magnitude of the anisotropy in multiple time windows is measured by the method of SC91 (Silver and Chan, 1991). Then, quality evaluation is performed using cluster analysis (Teanby et al., 2004) from measured values measured from multiple time windows. MFAST is a program that automates this sequence. It can process large amounts of data automatically and more quickly than the conventional method and obtain objective and reliable measurements.

We used data from temporary stations and routinely operated stations in the entire Tohoku region from Dec. 2008 to Apr. 2016. The analysis using shallow earthquakes in the crust showed stress-induced anisotropy generally along the direction of the maximum horizontal compressive stress axis (SHmax). However, structural anisotropy with fast azimuth along the strike of the fault was also observed in some areas on the western back-arc side, and it was confirmed that the direction changed in a small spatial range. The direction of the anisotropy did not change significantly before and after the Tohoku-Oki earthquake. However, the anisotropy apparently increased in the region of high seismicity after the Tohoku-Oki earthquake. There were some areas where the change in the magnitude of anisotropy due to the Tohoku-Oki earthquake is consistent with the stress change.

In the analysis of the aftershocks of the 2008 Iwate-Miyagi Nairiku earthquake, we found that the direction of anisotropy and the direction of stress changed in a small spatial range. We also found that the anisotropy decreased in the region of the Iwate-Miyagi Nairiku aftershocks after the Tohoku-Oki earthquake, which is consistent with the previous studies that the seismic activity in this region was possibly reduced due to negative stress change.

