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MAGNETIC FIELD OBSERVATIONS FOR THE 11 NOVEMBER 2016 MW=6.1 JAPAN, EARTHQUAKE

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Any parameter that changes before the occurrence of an earthquake and helps us to predict an earthquake is called a precursor. The presence of anomalies in geomagnetic data is one of the earthquake precursors which are known for a long time. Recent reports suggest that large magnetic field changes occur prior to earthquakes. Many investigators have reported observations of unusual magnetic field behavior associated with seismic activity. These changes accompanying earthquakes have been observed in regions subject to earthquake hazard (e.g., Johnston et al., 1994). Time-dependent local magnetic anomalies are expected to result from stress changes that accompany seismic fault failure (Stacey and Johnston, 1972). Magnetic field changes were clearly observed to accompany the 8 July 1986 ML 5.9 North Palm Springs earthquake (Johnston and Mueller, 1987), the 18 October 1989 ML 7.1 Loma Prieta earthquake (Mueller and Johnston, 1990), the 28 June 1992 ML 7.3 Landers earthquake (Johnston et al., 1994) and the 28 September 2004 M 6.0 Parkfield Earthquake (Johnston et al., 2006). These observations are explained in terms of piezomagnetic changes in crustal rocks expected based on the stress changes calculated from geodetic and seismologic models (Johnston et al., 2006). They showed that seismomagnetic effects are a normal feature of earthquakes with M > 6.0.

A moderate earthquake (Mw = 6.1) occurred at a depth of 42.4 km, approximately 24 km ENE of Ishinomaki, Japan, at 21:42:59 (UTC) on 11 November 2016 (Figure 1). This earthquake provided an opportunity to verify the reality of the seismomagnetic effect.

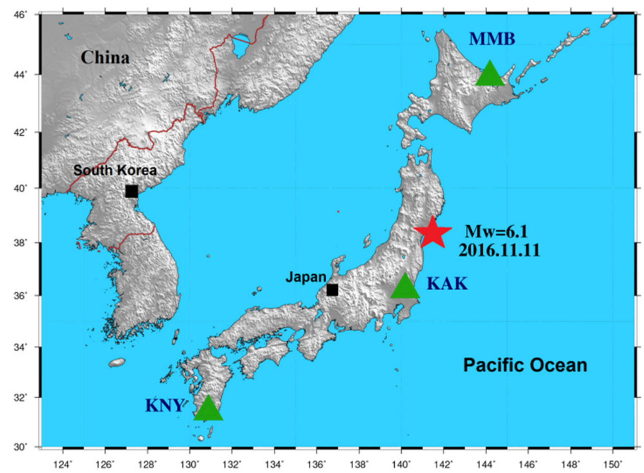

Figure 1. Regional map, red star represents epicenter of the earthquake and green triangles represent location of the geomagnetic observation sites.

In this study, we have examined magnetic field data, provided by the global network of observatories, monitoring the Earth's magnetic field namely INTERMAGNET from three stations around epicenter of this earthquake (Figure 1). Three operating proton precession magnetometers had been installed at distances of 167 km, 762 km and 1168 km from the epicenter of the earthquake, and have been sampling every one minute. In this case study, we use characteristic curve method for geomagnetic data processing (Pourbeyranvand and Dehghani, 2015). The characteristic curve is formed for different components of the magnetic field in various magnetic stations by over-plotting the magnetic data in a 24-hour time period during 2016/06/01 to 2017/06/01. This procedure is performed for removing magnetic diurnal variations from geomagnetic records. We used the corrected magnetic field record four days before, and eight days after the earthquake as shown in Figure 2.

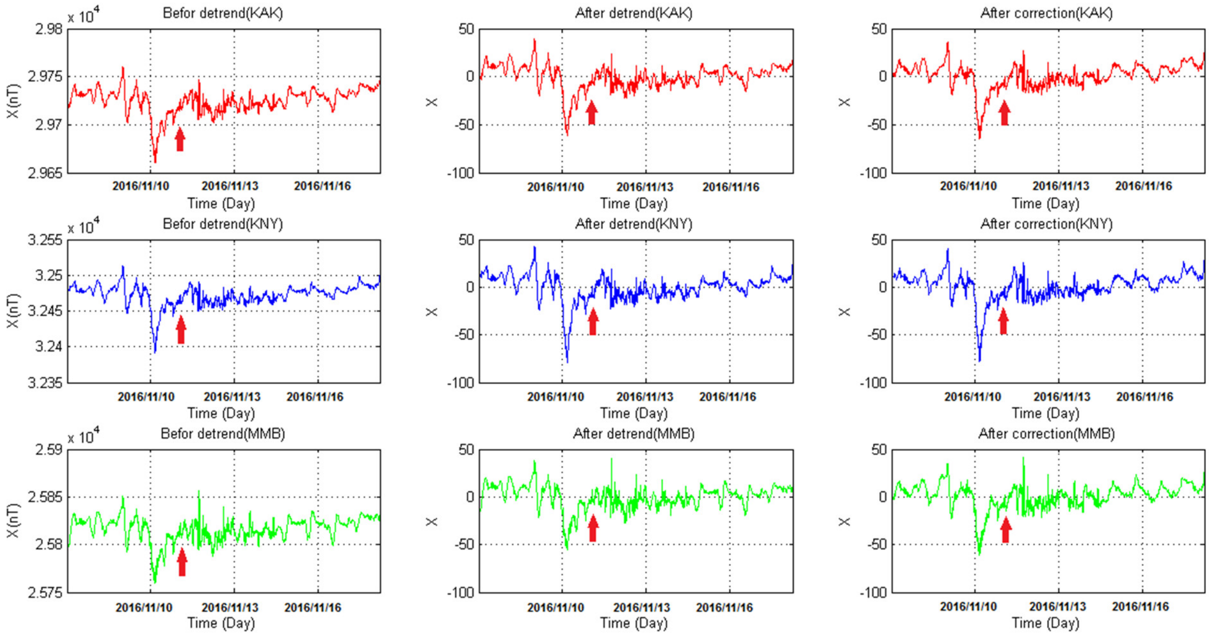

Figure 2. The magnetic field in three sites, KAK, KNY, and MMB, four days before and eight days after the earthquake (occurrence time indicated by a red upward arrow).

Figure 2 shows that the magnetic field decreases in the stations close to the epicenter of the 11 November 2016 Mw = 6.1 Japan earthquake on 10 November 2016. On the other hand, no geomagnetic storms were observed on 10 November 2016. These magnetic field decreases are probably resulted from stress-induced reversible changes in piezomagnetic effects. Thus, according to our findings, geomagnetic anomalies can be used as an earthquake precursor.

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