Does the tsunami-generated magnetic field arrive earlier than the sealevel change?

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The motion of the seawater in the geomagnetic field can generate the induced electromagnetic (EM) field. Tsunamis, therefore, can generate the EM field which has been detected by ground and seafloor EM stations. Ground EM stations can only receive the poloidal component of the tsunami-generated magnetic field, while seafloor stations can receive not only the poloidal component but also the toroidal component with better signal-to-noise ratios (Schnepf et al., 2016). The tsunami-generated vertical magnetic field, bz, and the sealevel change by tsunamis have a direct relationship with each other (Tyler, 2005).

By detecting the sealevel change, we can build a tsunami early warning system; the same is applicable by detecting the tsunami-generated magnetic field. Minami et al. (2015) show that the tsunami-generated bz has the phase lead with respect to the sealevel change by tsunamis. It means that the magnetic field may be more effective for early warning purposes than the sealevel change. In the 2006 and 2007 Kuril earthquake events, bz arrived earlier than the tsunami-generated bz and bz which are considered in phase with the sealevel change (Toh et al., 2011). However, in the 2010 Chile earthquake event, the tsunami-generated bz has been reported to have arrived in phase with the sealevel change (Sugioka et al., 2013).

In order to clarify the relationship between bz and the sealevel change by tsunamis, we compared the arrival time of bz and the sealevel change in the 2009 Samoa and 2010 Chile tsunami events. Since the tsunami-generated magnetic signal contains a variety of frequency components, we compared the phase lead of bz with the sealevel change for different frequencies.

Our magnetic and sealevel change data were observed at Site SOC8 by the TIARES experiment conducted at the French Polynesian seafloor from 2009 through 2010 (Suetsugu et al., 2012). This data contain the tsunami signals of the 2009 Samoa and 2010 Chile earthquake events. Sampling intervals of sealevel change and magnetic signals are 1 second and 1 minute, respectively. We compared the tsunami arrival time of bz and sealevel change. The bz signal was processed by a zero-phase filter to remove variations whose periods were not in the tsunami period band (5min˜60min). Raw sealevel change was deconvoluted by following the procedure by Araki and Sugioka (2009). We then compared the tsunami arrival time of bz and sealevel change for the periods of 7min, 15min, and 30min. We used a wavelet analysis method to show the frequency dependence of the tsunami arrival time.

Our preliminary result shows that the tsunami-generated bz have a small phase lead to the sealevel change, which is in harmony with Minami et al. (2015). In addition, at longer periods, the tsunami-generated bz has larger phase lead to the sealevel change. Although this result still needs further examination, it may lead to building the tsunami early warning system based on the detected magnetic field.