フレンチ・ポリネシアでの津波電磁気シグナルの海底アレー観測

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Seafloor array observation of the electromagnetic tsunami signals in the French Polynesia region

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We deployed the TIARES network in the French Polynesia region in order to obtain seismic and electrical conductivity structures of the mantle beneath the Society hotspot (Suetsugu et al. 2011, Tada et al., 2011). The seafloor network covers 500 km by 500 km area close to the Society hotspot, and is composed of 9 observational sites, each of which is equipped with a pair of broadband ocean bottom seismometer(BBOBS) and ocean bottom electro-magnetometers(OBEM), In addition to this, a differential pressure gauge (DPG) is installed at one station(SOC8). The apparatuses were installed in March 2009, and recovered in November-December 2010. During the operating period of the TIARES network, two big tsunami earthquakes occurred in the South Pacific. The one is the Chilean earthquake (Mw 8.8) occurred off the coast of Chile (35.85S, 72.72W) on February 27, 2010, and the other is the Samoa earthquake (Mw 8.0) occurred 195 km south of Apia (15.56S, 172.09W) on September 29, 2009. Magnetic field variations due to the tsunami waves from these two earthquakes were clearly observed by the DPG and all the OBEMs in the TIARES network (Hamano et al., 2011). These observations provide first opportunity to investigate the tsunami propagation in the open sea by using seafloor array measurements.

The seafloor measurement of the EM signals due to tsunamis had not been attained until very recently (Toh et al., 2011) because of their low signal levels. However, recent advances in high precision measurements of electric and magnetic field enabled the seafloor measurements of the tsunami signals. Offshore sea-level measurement using the bottom pressure gauges provide useful information for detection and warning of tsunami before its arrival at the coast. Since the measurement of EM signals from tsunamis detect the propagation direction as well as particle motion of seawater, which supplement the sea level change inferred from the bottom pressure gauge, Moreover, seafloor array measurements of the EM signals can become very powerful tool for monitoring the tsunami propagation in deep oceans.

In the present observations, tsunami EM signals are evident in three components of the magnetic field (Bx, By, Bz), and the variations lasted more than several hours after the passage of the tsunami front. Close correlation between the temporal variations of the magnetic field and the sea level change observed by the DPG at site SOC8, indicates that the EM field variations are mainly caused by the tsunami waves . Comparison of the amplitudes of the magnetic field variation with the sealevel change indicates the magnetic variation of 0.4 nT roughly corresponds to 4 cm of sealevel change. The conversion factor q, defined by (b/Fz) = q(h/H), where b is the change of the magnetic field, Fz is the vertical component of the ambient geomagnetic field (=19500 nT at SOC8), h is the sealevel change, and H is the water depth (=4800 m at SOC8), is estimated to be about 2.5, which is much higher than that obatained at the northwest pacific site NWP (q = 0.85). The variation of the conversion factor may reflect the electrical conductivity structure under the seafloor. Since the waveforms of the EM field variations are very similar among the 9 stations, the propagation characteristics of the tsunami wave over the network area can be accurately restored from the EM measurements. The inferred propagation direction of the 2010 Chilean tsunami is towards N75W and the propagation speed is about 720 km/hour. On the other hand, the direction of the tsunami from the Samoa earthquake is towards N80E. Since the average water depth is 4000-4800 m, the observed speed is consistent with a long-wave approximation of the tsunami propagation, and the direction of the tsunami propagation is determined by the epicenter of the earthquakes. Further waveform analysis of tsunami signals will reveal the detailed sturucture of the tsunami

propagation in the deep ocean.