MT survey and monitoring to reveal the characteristics of deep low-frequency tremor area beneath western Shikoku, southwest Japan

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Deep low-frequency tremors and short-term slow slip events synchronously occur in the Nankai trough subduction zone in southwest Japan (Obara, 2002; Hirose and Obara, 2005). Those events are periodically activated beneath western Shikoku with the interval of approximately six months. Shelly et al. (2006) revealed that the tremors occur at the transition zone between the locked and creeping sections on the plate interface by conducting the precise relocation of low-frequency- and ordinary-earthquakes, and also the seismic wave tomography. They also reported that they found the zone of high Vp/Vs ratio, which was interpreted as the high pore-fluid pressure, in the vicinity of the tremors area. Matsubara et al. (2008) estimated the seismic velocity structure beneath southwest Japan with the seismic tomography, and revealed that the tremors occur at the area where the subducting Philippine Sea plate first comes into contact with the serpentinized wedge mantle of the Eurasian plate. These suggestions about the characteristics of tremors area can be further constrained by investigating another physical property such as an electrical property of rocks. From the point of view, we conducted the electrical resistivity survey with the magnetotelluric (MT) method and also started the monitoring of resistivity structure.

Before the resistivity survey, we installed two sets of MT measurement system in the western Shikoku region for monitoring change in resistivity structure. The MT monitoring should be conducted at the area where the electromagnetic noise is as little as possible, because the low-frequency MT data, which have the electrical information at depth, need extremely quiet environment to be stably and precisely acquired. However, continuous system operation and data transmission need an electrical power source and a telephone circuit. So, we performed preliminary observations for two days at six candidate sites where the above infrastructures were available, and selected two sites where the noise levels were lowest. Both of these two sites are located just above the tremors area. The MT measurement systems are MTU-5S produced by Phoenix Geophysics Ltd. Using this system, we are recording two components of electric field and three components of magnetic field from September 2008. Although any meaningful resistivity change related to events has not ever been found, it may become detectable by sorting out the measured MT data by a threshold such as an intensity of magnetic signals.

After installing MT monitoring systems, we carried out wideband MT survey. We acquired MT data at 12 sites on a line with the length of approximately 80 km. The MT survey line was almost parallel to the NS-line for seismic exploration conducted by Takeda et al. (2008), and was approximately 20 km away from the seismic survey line to the west. The two monitoring sites are also located on the MT survey line. Using MTU-5 system, we continuously measured two electric and three magnetic field longer than 140 hours at all sites from 25 September to 10 October 2008. After remote reference data processing, we estimated two-dimensional resistivity structure by using inversion code of Ogawa and Uchida (1996). In the inversion, we analyzed apparent resistivity and phase data of TE and TM modes including the data acquired at two monitoring sites in the frequency range between 320 and 0.000086 Hz.

The results show that low-resistivity zone (several tens ohm-m) are lying beneath the MT survey line with the depth from ˜5 to 20 km. In contrast to the shallower region, there exists high-resistivity block (several hundreds ohm-m) deeper than ˜40 km at the central part of MT survey line. We will discuss the physical property and characteristic of the tremors area estimated from a comparison between our resistivity structure and the structures estimated with the seismic methods (Shelly et al., 2006; Matsubara et al., 2008; Takeda et al., 2008).