

LEMI 長周期 MT 観測装置の周波数特性の検定について

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Calibration of the LEMI long-period MT instruments

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The LEMI long-period magnetotelluric (MT) instrument measures 3 component magnetic field with a fluxgate sensor and 4 channel electrical potential differences. Due to low power consumption and good quality of the magnetic sensor against temperature drift, the instrument is widely used in the MT community in the world. We also used the instruments for surveys in several target areas such as Tohoku, Kii Peninsula, and North Island of the New Zealand. After estimating the MT impedance between the electric field and the magnetic field, however, we found anomalous behavior of impedance especially in the phase in the shorter period range (shorter than 100s). In many cases, the phase value decreases toward the shorter periods. Thus, unless we get the calibration table for the instruments, we cannot obtain the correct impedances and estimate the true resistivity structure. The manufacturer only gave us a single typical calibration table, where frequency characteristics, however, were somewhat different from channel to channel and not very reliable.

Thus it is very important to determine the calibration table for respective channels in the MT recorders of respective serial numbers. In order to realize this, we performed the parallel MT observation at Samegawa site in Fukushima prefecture. We install one wide-band MT system (ADU08e produced by Metronix) and four LEMIs in the field. ADU08e measured 2 component electric fields and 3 component magnetic fields by using induction coils at 32 Hz sampling rate. All the electric channels of all the LEMIs measured the electric field of EW component and respective LEMIs measures 3 component magnetic field with respective fluxgate sensors at 1 Hz sampling rate. We obtained the records for about two months from June to August, 2025.

We estimated the response functions in the period range from 4s to 10^4 s between EW component electric fields obtained by respective LEMIs and the ADU08e. We also estimated the response functions between vertical components obtained by respective LEMIs and the ADU08e. In this estimation, we used the BIRRP code developed by Chave and Thomson (2004). For the electric field, the phase value starts to decrease from 100s and reaches about -150 degree at 4s. The minus sign indicates phase delay of LEMIs against the ADU. About the magnetic field we only estimate response functions between vertical component of respective LEMIs and that of ADU. In comparison with the electric field, the magnetic field response functions are not very stable and some scatters are detected. Moreover, we cannot estimate response functions for horizontal components since orientation of the sensors cannot be aligned. In spite of this difficulty, we found that magnetic field phase rotation is at most -15 degree throughout the period range. This result is consistent with our experience in MT impedance estimation mentioned above. But there exists some variation of the frequency characteristics from channel to channel and serial number to serial number. We realized that we have to do further efforts to obtain correct calibration table, especially for magnetic channels.