# Estimation of the seafloor electromagnetic responses in the mixed excitations band by using Sompi Spectral Analysis

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Electromagnetic (EM) responses such as magnetotelluric (MT) impedance and geomagnetic depth sounding (GDS) response in the period range between several minutes to one day are used to study the electrical conductivity in the upper mantle. Spatially uniform and quasi-random magnetic field variations due to geomagnetic disturbances are considered as the source field in regional EM induction studies using the EM responses. However, the magnetic field variations in the period range from $10^4$ to $10^5$ seconds contain those with different spatial structure such as the solar quiet (Sq) daily variations and those induced by the ocean tide. Because of this, the period band is referred to as mixed excitation band (ME band). Careful treatment of EM field data is necessary to estimate responses in the ME band that reflect actual conductivity structure. For example, Baba eta al. (2010) estimated the EM responses using a method based on Fourier transform after removing line spectra of EM field variations at periods of Sq field variation and constituents of ocean tides. However, it has been shown that the estimated observed responses in the ME band still contain signatures of non-uniform and westward- propagating source field (Shimizu et al., 2011). Estimating EM responses free from these effects in the ME band is a challenge for the ocean bottom EM induction studies. In this study, we aim to have better estimates of EM responses in the ME band by selecting signals of the vertically propagating plane-wave source carefully. For this purpose, we employ the Sompi method (e.g., Kumazawa et al.,1990) that can identify existing wave elements (or namisos) in time series with a high frequency resolution. The Sompi method is applied for two horizontal magnetic field components at once (Asakawa eta al.,1988) to find complex frequency of namisos and then the amplitude and phase of three magnetic field and two horizontal electric field components are determined by assuming that they have common frequency of variation. Obtained line spectra for the EM fields are used to select suitable namisos for EM response estimation by a least square method. The criteria to select namisos are (1) selecting namisos in period ranges that are sufficiently away from those of Sq harmonics and ocean tides, (2) selecting namisos that do not show the westward propagating nature similar to the Sq field, and (3) selecting namisos with a quasi-linear polarization in the vertical plane. In this study, we applied criterion (1) at first. Then, the criteria (2) and (3) were applied to the namisos selected by criterion (1) separately. It was confirmed that responses estimated using (2) or (3) at periods shorter than $10^4$ seconds are almost identical to those estimated by Baba et al., (2010) within the estimation error at periods shorter than $10^4$ seconds. However, the abrupt change of EM responses at periods around $10^4$ seconds in the previous work became smaller after applying criterion (2). On the other hand, the value of EM responses estimated using criterion (3) also reduced significantly at the shorter period of the ME band. Results of these two cases show that signatures of the Sq field variation in the EM responses are reduced at the shorter period part of the ME band up to $2\times10^4$ seconds. However, we could not obtain statistically significant responses at longer periods because sufficient number of namisos was not available after the namiso selections. Using Sq field variation itself as the source field at the longer period in the ME band is another way to utilize EM field information to constrain the electrical conductivity of the mantle.

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