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Detection and characterization of cultural noise sources in magnetotelluric data: individual and joint analysis of the polarization attributes of the electric and magnetic field time-series in the time-frequency domain

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Magnetotelluric (MT) method is a passive electromagnetic technique, which is currently used to characterize sites for the geological storage of CO_2. These later ones are usually located nearby industrialized, urban or farming areas, where man-made electromagnetic (EM) signals contaminate the MT data. The identification and characterization of the artificial EM sources which generate the so-called "cultural noise" is an important challenge to obtain the most reliable results with the MT method.

The polarization attributes of an EM signal (tilt angle, ellipticity and phase difference between its orthogonal components) are related to the character of its source. In a previous work (Escalas et al. 2011), we proposed a method to distinguish natural signal from cultural noise in the raw MT data. It is based on the polarization analysis of the MT time-series in the time-frequency domain, using a wavelet scheme. We developed an algorithm to implement the method, and was tested with both synthetic and field data. In 2010, we carried out a controlled-source electromagnetic (CSEM) experiment in the Hontomín site (the Research Laboratory on Geological Storage of CO_2 in Spain). MT time-series were contaminated at different frequencies with the signal emitted by a controlled artificial EM source: two electric dipoles (1 km long, arranged in North-South and East-West directions). The analysis with our algorithm of the electric field time-series acquired in this experiment was successful: the polarization attributes of both the natural and artificial signal were obtained in the time-frequency domain, highlighting their differences.

The processing of the magnetic field time-series acquired in the Hontomín experiment has been done in the present work. This new analysis of the polarization attributes of the magnetic field data has provided additional information to detect the contribution of the artificial source in the measured data. Moreover, the joint analysis of the polarization attributes of the electric and magnetic field has been crucial to fully characterize the properties and the location of the noise source.

Escalas, M., Queralt, P., Ledo, J., Marcuello, A., 2011. Identification of cultural noise sources in magnetotelluric data: estimating polarization attributes in the time-frequency domain using wavelet analysis. Geophysical Research Abstracts Vol. 13, EGU2011-6085. EGU General Assembly 2011.