

Theory and practice of Controlled Source Audio-frequency Magneto-Tellurics: discussion on two case studies in France, at the Rochechouart impact structure and at the Strengbach catchment

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SUMMARY

Audio-frequency Magneto-Tellurics (AMT) is a passive noninvasive prospecting method; it is based on the electromagnetic induction in the ground from background electromagnetic plane waves caused by far distance sources of natural or anthropic origins; their frequency range is 20 Hz-20 kHz. Controlled Source Audio-frequency Magneto-Tellurics (CSAMT) method is an alternative to AMT which is considered to cope with practical field situations where background anthropic noise from near sources has high amplitudes compared to other incident electromagnetic waves; controlled source can be used to avoid high acquisition times or advanced robust processing that are necessary in AMT (Larnier et al. 2018). Controlled source is particularly interesting at frequencies in the so-called "AMT-dead band" of low natural activity near 1-3 kHz, corresponding to skin-depth of tens to hundreds of meters, depending on the underground resistivities.

In CSAMT theoretical principles, transmitter must be a set of large electric dipoles (hundreds of m) located far from the receiver area (tens of km); this geometry is necessary to eventually obtain good estimates of all impedance tensor components. However, actual field situations often impose different configurations with shorter dimensions, and one should deal with the measured electric and magnetic records by using the more general theoretical framework of Controlled Source Electro-Magnetic (CSEM) methods.

We consider two case studies of CSAMT surveys whose size of the electric transmitter antenna is relatively small (100-300 m). One study shows of a profile at the Rochechouart-Chassenon impact structure, France (Quesnel et al. 2021); CSAMT was used because of one High Voltage power line crosses the breccia area of interest. The other study shows the investigation of the Strengbach catchment, France (Lajaunie et al. 2022); CSAMT was used because one telecommunication antenna is on the summit, at one boundary of the catchment. Papers cited above essentially show CSAMT apparent resistivities and their inversion with shallow ERT resistivities; a very few information has been shown concerning the underlying CSAMT questions: Experimental set-up as well as simulation of radiation patterns, data processing, apparent resistivities and inversion will be discussed at EMIW22.

Keywords: Controlled-Source Audio Magneto-Tellurics, CSAMT, Power line noise, radiation pattern

References

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