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A low cost ERT prototype in the Cultural Heritage monitoring

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Electrical Resistivity Tomography (ERT) is a well-established geophysical technique useful in geology and environmental studies. Its low intrusivity, which is a key feature for its success in the above-mentioned fields, can be a strong limitation for the systematic application of the ERT in the Cultural Heritage and civil infrastructures monitoring application fields.
In fact, usually, the injection of the electric current in the structure (or ground) is realized through stainless steel electrodes, which have to be fixed into the medium so to achieve a good electric contact with a low electrode resistance. However, Geophysical characterization of Cultural Heritage needs more stringent requirements in terms of minimal or not-intrusivity. To comply with this requirement, in this work an ERT system has been developed, which is based on the use of medical Ag/AgCl electrodes located on the structure also thanks to the help of and conductive gel so to keep low the electric contact resistance; the electrodes are excited by a classical DC georesistivimeter. Such a type of low cost electrodes makes it possible to perform non invasive diagnostics by also ensuring a stability of measurement in a time period comparable with the ones required for the survey in cultural heritage. In addition, the use of Ag/AgCl minimizes electrode polarization phenomena.
This work is concerned with the set-up and the testing of a prototypical ERT system, where the Ag/AgCl electrodes are commanded by the IRIS Syscal Junior georesistivimeter, which is of interest Cultural Heritage and civil infrastructures characterization and monitoring. Preliminary test have demonstrated the possibility to inject electrical current (10-30 mA) into reinforced concrete and marble and measure an induced voltage of the order of ranging from 0.1 to 10 mV; also the electrodes exhibit a good stability even if they are used as current electrodes. The use of an electroconductive material such as a water based gel, which is little “aggressive” to the surface of installation, has been identified as a solution to minimize the electrode resistance; this topic is significant, since classical georesistivimeters, such as the one here used, provide a resistance of 10 KOhm.
Finally, the prototype was designed and built by means of a multi-electrode cable formed by 48 Ag/AgCl electrodes 1m spaced, which is particularly suitable for the high spatial resolution and shallower layers inspection of interest Cultural Heritage purposes. Few preliminary tests have been performed on different construction samples and the results were well evaluated with respect to their “interpretability”, also thanks to the use of an inversion stage carried out by using the Res2DInv software(Loke and Baker, 1996). The system was effective in few situations and relatively inexpensive to be upgraded for tasks not originally conceived for this system. Anyway, several “applicative” problems have to be solved as well as the electrode positioning on not-horizontal surfaces, the effect of electro-conductive gel on precious materials surfaces and the effect of the current injection on electrode response quality.
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Loke, M.H., 2006. RES2DINV ver. 3.55, Rapid 2D resistivity and IP inversion using the least-squares method. Software Manual: 139pp.