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A new measurement protocol of ERT data

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DC resistivity methods are generally based on the measurements of electric potentials or potential differences caused by the current injected into the ground. However, measured potential differences can be severely contaminated by spurious potentials originating from a wide variety of external sources. Spurious potentials usually contain a DC component, several components at distinct frequencies (e.g., the 50/60 Hz frequency from power lines and its multiples), linear and nonlinear drifts and a non-coherent noise component. This parasitic potential (noise) may sometimes be substantially larger than the potential solely caused by the current (signal). Thus, it is important to eliminate this noise from the measurements.
Noise components of distinct frequencies can easily be eliminated either by filtering or adapting the measuring interval to multiples of the noise period. Non-linear drifts usually originate from bad electrode contacts or technical problems with the instrument. Therefore, such measurements should be either repeated or removed from the final data set. A common strategy for eliminating the DC noise component is to conduct measurements in forward and backward directions of the current flow, which can be accomplished by injecting current in square wave form. This method has historically been used as the basic framework for Earth resistivity meters. In this protocol, the difference between two consecutive readings during one cycle of +/- square-wave current is regarded as the target signal for measurement. In addition, the mean of the forward and backward potentials are regarded as spurious DC potentials that bias the true response. Spurious DC potentials measured in this manner must be identical to potentials measured without injecting current; this is a necessary condition for the validity of the resistivity measurement principle. Because self-potential (SP) is the observed potential when no current is injected, we refer to this spurious DC potential as SP estimated from DC resistivity measurement, although SP would be contaminated by noise (e.g., electrode polarization effects). However, in field measurements, SP estimated from resistivity measurement can be sometimes noticeably different from that measured without the current source, and the estimated SP may contain responses to the current (e.g., polarization effects) injected into the ground to measure resistances. Resistances obtained in this manner may be erroneous.

In this study, we propose a new protocol for measuring DC resistivity data, where SP data are obtained immediately prior to measuring DC resistivity. Measuring SP at this time allows to define two different resistances: forward resistance (i.e., a normalized potential difference caused by forward current injection) and backward resistance (i.e., a normalized potential difference caused by backward current injection). This allows for the quantification of errors in the measurements of DC resistivity in the field survey as well as distortions in the DC resistivity potential field caused by all unknown mechanisms but SP sources. In addition, we devised a new data-weighing scheme (based on forward and backward resistances) to obtain more reasonable subsurface structures. We validated this proposed method through inversion experiments.

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