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Correcting electrode impedance effects in broadband SIP measurements

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Broadband spectral induced polarization (SIP) measurements of the complex electrical resistivity can be affected by the contact impedance of the potential electrodes above 100 Hz. In this study, we present a correction procedure to remove electrode impedance effects from SIP measurements. The first step in this correction procedure is to estimate the electrode impedance using a measurement with reversed current and potential electrodes. In a second step, this estimated electrode impedance is used to correct SIP measurements based on a simplified electrical model of the SIP measurement system. We evaluated this new correction procedure using SIP measurements on water because of the well-defined dielectric properties. It was found that the difference between the corrected and expected phase of the complex electrical resistivity of water was below 0.1 mrad at 1 kHz for a wide range of electrode impedances. In addition, SIP measurements on a saturated unconsolidated sediment sample with two types of potential electrodes showed that the measured phase of the electrical resistivity was very similar (difference <0.2 mrad) up to a frequency of 10 kHz after the effect of the different electrode impedances was removed. Finally, SIP measurements on variably saturated unconsolidated sand were made. Here, the plausibility of the phase of the electrical resistivity was improved for frequencies up to 1 kHz, but errors remained for higher frequencies due to the approximate nature of the electrode impedance estimates and some remaining unknown parasitic capacitances that led to current leakage. It was concluded that the proposed correction procedure for SIP measurements improved the accuracy of the phase measurements by an order of magnitude in the kHz frequency range. Further improvement of this accuracy requires a method to accurately estimate parasitic capacitances in situ.