

Development and performance of solid Pb-PbCl₂ non-polarized electrode

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Non-polarized electrodes are used to measure the potential differences between two points of ionic conductors. They have been widely used in geoelectric measurements, e.g., magnetotelluric (MT), induced polarization (IP), and spontaneous potential (SP). In practical applications, non-polarized electrodes have the following shortcomings: (1) Regular maintenance is required, and the electrodes must be placed in a special solution after use. (2) The working life is limited due to improper maintenance. (3) The electrode is large and generally weighs more than 0.5 kg. (4) The electrode temperature coefficient is usually 0.1~1 mV/°C which is required to be buried deep (>1 m) for long-term observation.

We have developed a maintenance-free solid Pb-PbCl₂ non-polarized electrode. The electrode has the following advantages. (1) No maintenance is required, the bottom of the electrode is sealed with a rubber sheath. (2) The potential of electrodes is stable, with a monthly drift of less than 50 μV. (3) The temperature coefficient is 10-20 μV/°C. (4) For 100 m electrode distance, the signal-to-noise ratio relative to the natural induced electric field is >20 dB at periods of 10,000 s and 10 dB at periods of 100,000 s, comparing 10 dB and -10 dB for PMS 9000 electrodes, respectively. We developed five types of electrodes for different measurements. The smallest diameter is 2.5 cm and 10 cm in height, and the weight is 0.1 kg which can be also used in the lab. All types of electrode are waterproof and can be used for the measurement of the electric field in waters, e.g., lake bottom.

The field test shows that our electrode can significantly improve the data quality at dead-band (0.1-10 s) and low-frequency for MT measurement, e.g., one can obtain smooth MT impedance with a period of more than 50,000 s for a month acquisition.