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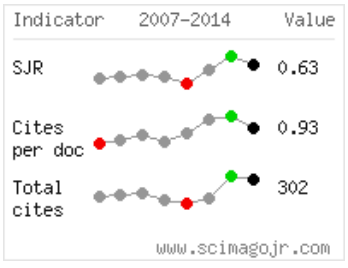

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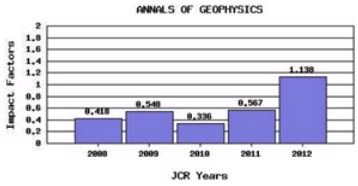

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Research Articles

Performance of electrical spectroscopy using a RESPER probe to measure salinity and water content of concrete and terrestrial soil

Alessandro Settimi

Abstract

This paper discusses the performance of electrical spectroscopy using a RESPER probe to measure the salinity s and volumetric content θ_W of the water in concrete or terrestrial soil. The RESPER probe is an induction device for spectroscopy which performs simultaneous and non invasive measurements of the electrical RESistivity $1/\sigma$ and relative dielectric PERmittivity ε_r of a subjacent medium. Numerical simulations establish that the RESPER can measure σ and ε with inaccuracies below a predefined limit (10%) up to the high frequency band (HF). Conductivity is related to salinity and dielectric permittivity to volumetric water content using suitably refined theoretical models which are consistent with the predictions of Archie's and Topp's empirical laws. The better the agreement, the lower the hygroscopic water content and the higher s; so closer agreement is found with concrete containing almost no bonded water molecules provided these are characterized by a high σ. A novelty of the present paper is the application of a mathematical–physical model to the propagation of errors in the measurements, based on a sensitivity functions tool. The inaccuracy of salinity (water content) is the ratio (product) between the conductivity (permittivity) inaccuracy, specified by the probe, and the sensitivity function of salinity (water content) relative to conductivity (permittivity), derived from the constitutive equations of the medium. The main result is the model's prediction that the lower the inaccuracy for the measurements of s and θ_W (decreasing by as much as an order of magnitude from 10% to 1%), the higher σ; so the inaccuracy for soil is lower. The proposed physical explanation is that water molecules are mostly dispersed as H^+ and OH^- ions throughout the volume of concrete but are almost all concentrated as bonded H_2O molecules only at the surface of soil.

Keywords

Explorative Geophysics; Concrete and Terrestrial Soil; Non-destructive Testing Methods; Electrical Resistivity and Salinity; Permittivity and Volumetric Water Content.

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