Geophysical Research Abstracts
Vol. 12, EGU2010-12804, 2010
EGU General Assembly 2010

Acquisition of electrical resistivity data. Application to soil moisture content

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Geophysical investigation such as detecting electrical resistivity or conductivity of soil has been applied in other to seek correlations between soil properties and soil state. There may be a lot of reasons for variation of the electrical soil apparent resistivity (bulk density, hydraulic conductivity, pore distribution, porosity), but in the same type of non polluted soil, the changes of electrical resistivity data are mainly due to the differential water retention.
Detecting even small modification in soil moisture content (<5Ωm) it is possible if optimum acquisition and processing techniques are applied.
Apparent resistivity acquisition is mainly due by using Wenner, Schlumberger or the hybrid Wenner-Schlumberger and Gradient-Dipol arrays. Investigating the same area with the different array may lead to slight different results (differences of the extent or intensity of the electrical resistivity anomalies). This is mainly a cause of the specific sensitivity functions for each of the above mentioned arrays. Comparing the sensitivity function for various array disadvantages and recommendation for using one or another in a specific site location can be outlined and it is a recommended step before starting the acquisition campaign.
Other important parameter that must be considered when geoelectric measurements are designed is the distance between electrodes. Electrical prospecting in DC makes use of metal electrodes implanted into the soil. Consequently, current electrodes, as well as potential electrodes, can only approximately be described as point source electrodes. Geoelectrical measurements made on cultivated soil showed that in case of the improper choose of the distance between the electrodes (1m) small changes in the soil moisture content at shallow depths could not be delineated, resulting an higher estimation of the soil water content, as has been revealed by apparent resistivity measurements made with electrodes positioned at half distance.
The results will be of high quality if the distance between electrodes is smaller, but placing too close the electrodes the point-source approximation of the injection electrodes may not accomplish. If the point-source approximation cannot be accomplished certain difficulties in the results interpretation will be encountered.
In order to illustrate the difference between values computed under the assumption of a point-electrode, and values obtained under the more realistic assumption that a real electrode, of finite length, was utilized. There has been computed the potential generated in a certain point , by a current source of length , that injected a current of intensity into a homogeneous and isotropic half-space of resistivity . Analyzes made for the Schlumberger array indicates that the apparent resistivity computed in the case of a line-electrode is equal to the apparent resistivity corresponding to a point-electrode only if the distance between the current source and the point (where the electrical potential is measured) is much larger that the electrode burying-depth . The distance between the current source and the point has to be at least four times larger than the electrode burying-depth, in order to secure differences smaller than 5% between the actually computed resistivity values and values existing in the ideal case. In addition, by taking into account the circumstance that both the current electrodes, and the potential electrodes, are actually linear, the electrodes separation must be at least 5-7 times larger than their burying-depth. The latter observation is of utmost importance in carrying out resistivity tomographies for soils, when shallow depth investigation it is needed.

The scientific researches were performed with financial support from the CNCSIS-UEFISCU 992/2009 and 998/2009 scientific projects.