NEAR-SURFACE INHOMOGENEITIES EFFECTS ON INVESTIGATIONS BY RESISTIVITY AND GPR METHODS: APPLICATION TO A WATERSHED IN RAIN FOREST OF CAMEROON

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Resistivity methods play a major role in mineral resources exploration and in environmental and geotechnical investigations. Resisistivity surveys are capable of mapping overburden, faults, fractures, salt water intrusions... using surface measurements of apparent resistivity. However, if inhomogeneities outcrop at the surface, current or potential electrode placement may have a significant effect on the data (Van Nostrand and Cook, 1966). Resistivity field data analysis for different regions have shown that the distortion of vertical electric sounding (VES) curves, caused by near-surface inhomogeneities (NSI or geological noise) may be found at more than 70% of VES curves. That means wrong interpretation results for any VES data without suppression of geological noise. It is very important to consider NSI as a permanent part of VES field model and rebuild field measurement technology for minimizing distorting influence of inhomogeneities.

Distortions of VES data may be divided into two main types (Bobachev et al., 1990): caused by objects near potential electrodes (or P-effect), where VES curve only moves up or down along apparent resistivity axis without sharp changing its form, and near current electrodes (or C-effect), where the form of VES curve changes. When NSI influence is occasional, their suppression is a difficult problem, but with the help of new electrical sounding techniques, such as Resistivity Tomography (Shina, 1989), Electrical Imaging (Barker, 1992) or Total Elecrical Sounding (TES, Bobachev, 1990), their influence became regular and canceling is simpler. Measurements fulfill with the help of computerized multichannel instruments. All electrodes on one profile are connected to the instrument, which reconnects different combinations of current and potential electrodes in accordance with computer program. With the conventional VES technique, NSI distortions are nearly invisible, and their danger is underestimated. For inhomogeneous media investigations different resistivity arrays can be applied (pole-pole, dipole-dipole, pole-dipole, Schlumberger...). Each type of array has its good and bad sides. However, it was found that the distorting influence of NSI depends first on the type of array element (dipole or single) getting to NSI location; dipole element giving more strong distortion effects than the single one.

In this paper, we have applied the technology of TES (Bobachev, 1990) with canceling of geological noise to a resistivity data set collected over a partially known watershed in the rain forest of Cameroon. A pole-pole electrode configuration was employed in which one current and one potential electrode were selected on the array while the two other electrodes were placed sufficiently distant that they appeared to be at infinity. Resistivity survey of the area was carried out using the ABEM Lund System. However, to use TES it is preferable to have the pair of pole-dipole sounding (Amn and mnB) measured in the same point. We have then transformed the pole-pole apparent resistivity data into pole-dipole data.

Figure 1 shows pseudosections before (a, c) and after (b, d) filtering for Amn and mnB arrays respectively. Resistivity apparent field for the two pole-dipole arrays is highly distorted by NSI and by the very resistive body (VES 624-672) itself. P-effect from NSI is clear visible on pseudosections from VES 584 to 616 for mnB array (Fig. 1c) and from VES 688 to 768 for Amn array (Fig. 1a). The pseudosection for Amn array (Fig. 1a, b) show a pronounced asymetry. The resistivities are higher toward the right side of the pseudosection, i.e. in the direction of the transmitter pole at infinity. The pseudosections corresponding to the full Schlumberger (AmnB) array after summing up Amn+mnB before (e) and after (f) removing effect of distortions are shown in Figure 1e, f. Provided the subsurface is essentially 2-D and the measured profile is perpendicular to the strike direction, the Schlumberger apparent resistivity pseudosection after filtering (Fig. 1f) can be considered to be a very smoothed image of the ground below the profile.

Preliminary results of this survey show the potential of using Total Electrical Sounding to detect and remove distortions of the electric field caused by near-surface inhomogeneities. After removing distortions from VES curves, a most accurate quantitative interpretation can be undertaken to give 1-D and/or 2-D geoelectrical sections.

In addition to resistivity data, the utility of the acquisition of multi-frequency GPR data is enhanced by further complementary purposes. The observation of the quality of the shallower reflections gives clues for the existence and the location of potential NSI. Another information given by GPR imagery of underground targets, is related to the nature of the geometrical symetries involved, in order, for instance, to stand the usefulness of pole-dipole transformations. Finaly, the knowledge of the shape of contrasting geological bodies, will be an asset for testing the inversion of pseudosections, to discriminate when an increased number of iterations often leads to as set of revolving equivalent but unrealistic solutions. Hence, the complementarity of both methods, resistivity pseudosection and GPR prospection is obviously shown.

References

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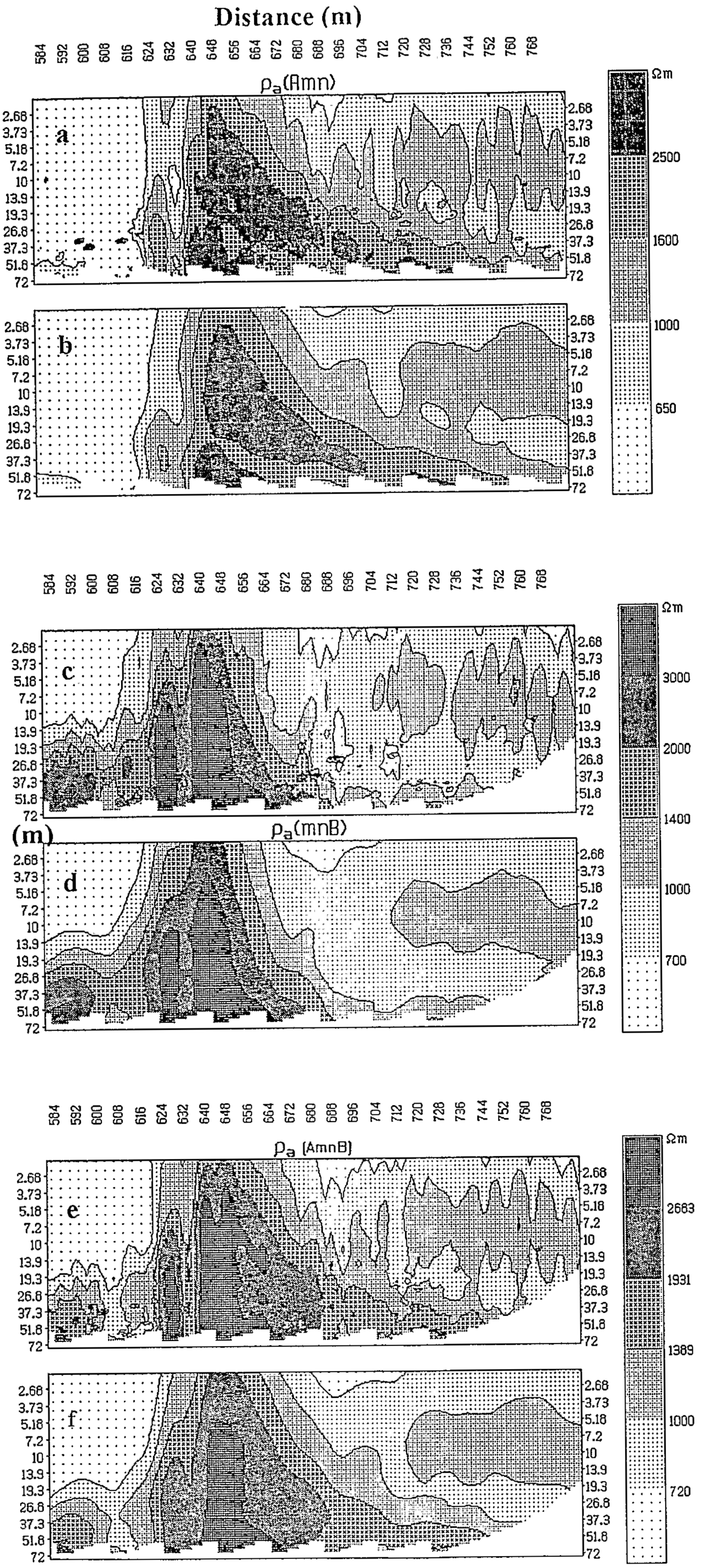

Figure 1: Field (a, c, e) and filtered (b,d, f) pseudosections

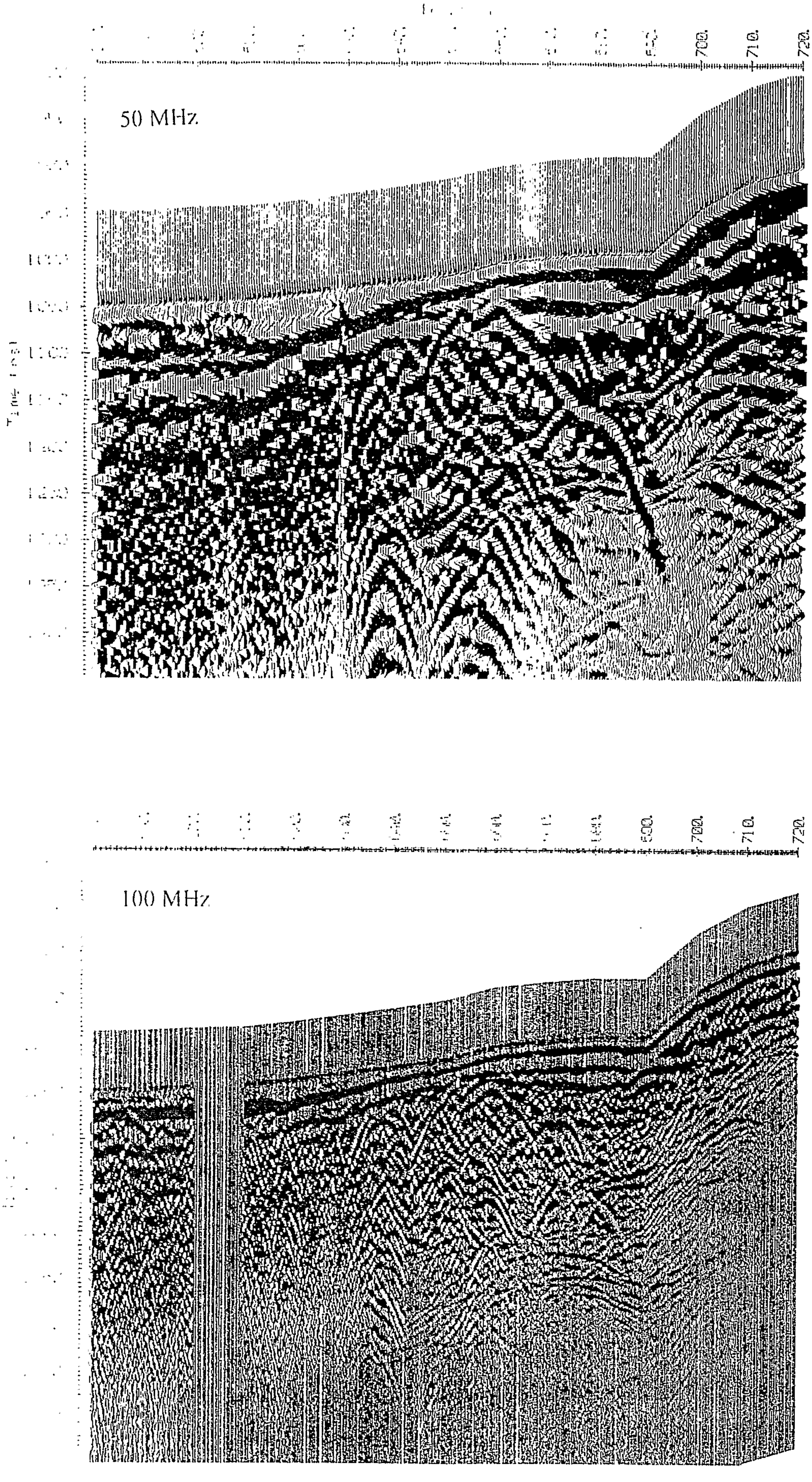

Figure 2: GPR sections between positions 580 and 720 m (SEC gain applied).

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