

Author's Feedback against Reviewer's Comment:

Comments on the paper « **Investigation of variation in resistivity with depth and soil compaction in parts of River State, Southern Nigeria**. By C.N. Nwanko, D.O. Ogagarue and F.O. Ezeoke.

General comments

The paper could be interesting but the lack of data and rigor make it unconvincing.

I believe that the paper can't be published in this state and needs major corrections.

I tried to make some remarks and comments following the reading, I hope that could help the authors.

Abstract

L 14 – “electrical properties of resistivity and dielectric polarization in relation to soil compaction, type and chemical constituents”. type and chemical constituents are too imprecise. Maybe in relation to soil texture and structure, density, soil moisture, and mineralogy?

The Reviewer's suggestion has been incorporated in the text.

L 19 – resistivity in $\Omega.m$ or surely electrical resistance in Ω This correction of $\Omega.m$ has been added.

L 21 –. May be better to write : the increase of the resistance accords to (or induce) the apparent resistivity increase

This line has been deleted.

L 21 –.the soil resistivity decreases with increasing of water content and associated ion concentration This line was replaced with other facts. This has been removed based on the improved restructuring of the entire Abstract

Key words : resistance, resistivity, dielectrical constant, soil structure

This suggestion has been accepted in parts

I Introduction

L 34 – “It is a very attractive method for soil characterization” is a repetition of line 31

This has been deleted

L 40 – information about the characteristics, extent ...texture, structure, water content, water salinity **Reviewer's suggestion is accepted and has been reflected on the text.**

L 45 to 49: In clay rich soils the moisture, the structure and compaction are intimately associated. The Archie law may be applied to the soil structure (Bernard-Ubertosi et al., 2009). In clayey soil, the electrical charges located at the surface of the clay particles induce a “surfacic conductivity” in addition to the electrolytic conductivity. The “surfacic conductivity” can be taken into account in the Archie law via the C.E.C. of the clay material (Waxman and Smith, 1968)

This suggestion is used to replace L45 to L49.

Archie, G., 1942. The electrical resistivity log as an aid in determining some reservoir characteristics. American Institute of Mining and Metallurgical Engineers, 154: 1-8.

Bernard-Ubertosi M., Dudoignon P. et Pons Y, 2009 - Characterization of structural profiles in clay-rich marsh soils by cone resistance and resistivity measurements. *Soil Science Society of America Journal* 73, 1, 46-54.

Waxman, M.H. and Smits, L.J.M., 1968. Electrical conductivities in oil-bearing shaly sands. *Journal of the Society of Petroleum Engineering*, 8: 107-102.

Banton et al., 1997

not found in the references This has been added

Fukue et al., 1999 **n**

ot found in the references This was deleted from the main text.

L 56 – The objective of the soil compaction for the road construction is to obtain dry density of the compacted material greater than 95% of the dry density obtained at the optimum proctor. That implies a “thin” range of water content for working to avoid the inefficient compaction of too dried or too wet material.

This suggestion has been effected

L 58 – chemical?.....

This has been removed owing to the modified objective of the study

L 62-69try to be simple and clear:

- General problems due to excessive concentration in NO₃ or other components and their implication on the precision of farming in the introduction
- Evolution of electrical properties of the compacted soil in your objectives because it accords with your measurements and results
- **The modification of the objective of the study has taken care of this simplification issue**

2 – geological description

L 80 – try to be more accurate on the location of your field investigation: marshes, sand bars? Add an accurate map of the location of your different sites of investigation in your figure 1

Figure 1 has been replaced with an accurate location map with different sites of investigation indicated.

3-Methodology

L 85-87 - Schematic figures of your measurement devices both in the drill holes (or in surface) and in laboratory (compaction + dielectric measurement) would aid to the explanation of your work and data. It could explain the relationship which can exist between the in situ measurements and laboratory samples.

The manner and steps in which the experiments were carried out both in the field and at the laboratory has been well simplified to remove the ambiguity of comprehension.

L 87-88.-. the list of parameters is very large and vague. It would be useful to give the equations of the resistivity and dielectric constant taking into account the soil characteristics.

Example for the Archie law:

$$\rho_s = \alpha \rho_w \phi^m \text{sat}^n$$

With ρ_s the soil resistivity, ρ_w the water resistivity, α , m and n the constant to be identified, ϕ the porosity and sat the saturation index.

For this relation the interesting parameters for the analyzed soils are water content, density porosity, thus calculated sat , and water resistivity (or salinity)...

The list of parameters has been reduced for clarity

L 90-92.-.So, the interest of a location map of your soil sampling.

The samples were collected from locations 3, 4 and 7 respectively (Fig. 1).

L 91-94.-Why to tie the samples in a cellophane bag? To in situ water content and density measurement ? but no data

They were put in a cellophane bag for preservation. Any other type of container might have as well served the purpose

Why to mix the sample with distilled water? The first consequence is to avoid the initial soil structure. May be it is to obtain an uniformity of material for the confection of the successive compacted samples. it is not clear. "To ensure the uniformity of the particles" is not the right word: mixing with water has no effect on the particle size or other.

To ensure the uniformity of the material was used in place of to ensure the uniformity of particles.

L 100 – Why (soil stabilization)? What is the soil stabilization for you? No lime or cement treatment so is it only a drying effect? It is a little bit confused:

Soil stabilization has been deleted and the sentence restructured

First step: The density of the compacted samples may be "controlled" by the water content introduced into the sample before the compaction following the recommendations for a Proctor test. The compacted state may be effectively controlled by the dry density of compacted material: bulk dry density B_d

$$B_d = M/V$$

With M the mass of the oven dried compacted material and V the volume of the soil or of the mould.

Second step: the compacted soil is oven dried at 105°C to reach a constant W content of 3% in weight. If it is this way : the drying to 3% W allows the electrical measurements at W constant and, thus, forces the electrical data to differences in structure for saturation index near 0. By drying effect, the mechanical characteristics of the material increase effectively, (compression resistance and shear strength) but surely not the permeability. The permeability evolves following the dried density of the compacted material, so following the W of compaction. It follows the dried density Proctor curve.

L 123-126 The density of the suspension were surely measured using the hydrometer at constant temperature and successive time intervals and associated average depths. So, according to the Stokes law (and not "different mathematical expressions"), the time intervals, the average depths of measurement and average real density of the mineralogical particles are used to calculate the sedimentation rates of aimed equivalent diameters. Indicate at least the aimed equivalent diameters and the equivalent diameters for sand, silt and clay in the table 1.

L 129 the vertical electrical soundings (VES) were carried out ...lack of figure representative of the electrode schlumberger configuration. If possible indicate the value of the frequency. Sorry, but in fact I do not understand how are measured the resistivity : schlumberger device in surface with AB increasing or electrode system introduced in the drill holes?

The Schlumberger Configuration survey method has been well explained. Drawing diagrams of this method, which is available in any geophysics text book that treats electrical resistivity method, has been ignored in order to be more concise.

L 139 - 140: in cases of surface investigation, the softwares used for the interpretation of the electrical soundings calculate equivalent resistivity/depth curves from measured data. For the resistivity sections the softwares calculate 2D "structure" of soil but, in spite of realistic calculations, the resistivities and depths are only calculated and apparent values.

The work is concerned only with the 1D variation of the vertical layer resistivities, thickness and depth. 2D structure could be better interpreted with other softwares if Wenner Array method was used in data acquisition. This is when fluid flow direction is needed, which is not part of the objective of this research.

4-Results and discussion

Figs 2-to-4 : It is possible to superimpose the 3 curves on the same diagram. It will be easier to compare the results.

This has been done.

The 3 curves shift from the lowest dielectric cst values up to the highest dielectric cst value according to the increase in sand% or decrease in clay%. It is difficult to have comments about the loamy characteristic. No quantitative data about the loamy characteristic of the soil... please precise if there is no organic matter content.

The suggested comment has been included in the text. No quantitative data interpretation was carried out for loamy soil.

The table 2 may be simplified by deleting columns "layers separations" and "height of drop" which are the same for the 3 soils.

The table has been re-drawn to effect the changes recommended.

L 163 Park-homenko 1967 not found in the references

This has been added.

L 170 Eberino and Ofoegbu 1992 not found in the references

The sentence where this reference referred was deleted.

Table 3 and l 171-175 : lack of description in the chapter 3 methodology which may be changed in material and methodology. No indications on the water content or density of the successive layer of drilled formations. No indication about an eventual water table.

Description of table 3 has been added in Methodology. The water table of survey Area is less than 4m (Fig. 3).

The paper may be interesting if you are able to explain how your dielectric constant measurements in laboratory can be used as tool or arguments to interpret the geophysical logs.

Which relationship can exist between the dielectric constants measured in laboratory and in situ measured resistivities. Do you have some equations or laws, which give such a dielectric constant / resistivity for materials, in order to argue about the interest to make the two type of measurement on the soils or rocks?

Normally the results would be presented as follow:

1-More accurate description of the studied drill holes (geological, textural, density,...)

and / or presentation (diagrams) of geo-electric sounding

2-arguments for the interpretation and calculations (may be based on you laboratory investigations). You need that for modeling such 5-to-7 layer structures! The complexity of the geophysical log may be an argument for developing laboratory investigation to aid the final interpretation.

3- final presentation of the calculated geophysical log.