Contamination and Organic Material Detection by Electro Resistivity Method

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ABSTRACT— *We present in this paper the report of an experiment to simulate the effect of the presence of saline solution on subsoil. The method used was Electro Resistivity, with employment of the Laying of Cables technique. The obtained results show that apparent resistivity is strongly influenced by the presence of toxic material, such as manure.*

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1. INTRODUCTION

A study on soil contamination aims to find anomalies that may affect the environment, therewith Electro Resistivity method was utilized to map the damage so that it can be softened.

With increasing human consumption, has become frequent, the accumulation of garbage in landfills, as a result of which manure produced can flow and achieve groundwater or an aquifer. Another case would be the manure released by putrefaction of corpses in a graveyard (which usually

lies in high places, such as hills), also having an impact on the aquifer and / or groundwater (GALLAS *et al* 2005).

Among the factors that increase the use of the Electro Resistivity method, for purposes of lithologic study, one of the most important is the difference in the soil potential. This situation is what allows the immense possibility of applying the method in environmental and hydrogeological studies, because the contaminated substances usually generates high salt concentration liquid. (GALLAS et al. 2005).

The experiment described in this work indicates that the apparent resistivity is strongly affected by the presence of saline solution.

2. MAIN TEXT

This study was conducted in an area within the campus UFVJM – Universidade Federal dos Vales do Jequitinhonha e Mucuri (Federal University of the Valleys of Jequitinhonha and Mucuri), in the municipality of Teófilo Otoni, state of Minas Gerais, using a simulation of the investigated event, by the opening of a trench to simulate a fractured aquifer, as described in figure (1).

Picture 1: experiment preparation

In geomorphological terms, the municipality is located in "Dissected Tablelands of Eastern Minas", in a "pontoons area", characterized by terrain forms evolved by the processes of differential erosion and concentric peeling. (MAGALHÃES JR., A.; MOREIRA, P. F.).

Belonging to the group of geo-electrical methods, the electrical resistivity is a geophysical method, whose principle is based on determining the electrical resistivity of the material which, along with the dielectric constant and the magnetic permeability, essentially express the electromagnetic properties of soils and rocks. The different types of materials on geological environment, have electrical resistivity as one of its fundamental parameter of physical properties, which reflects some of its features in order to identify their status, in terms of change, income, saturation, etc.., and even lithologically identify them without physical excavations" (BRAGA, A. C. O., 2007).

There are two main techniques of electrical resistivity method. They are the Vertical Electrical Sounding – VES and the Laying Of Cables – LOC. The VES technique consists of a series of geo-electrical parameter measurements, taken from ground surface, maintaining a growing separation between the transmission electrodes of electrical stream and potential. When the electrodes are

symmetrically aligned on the ground surface, and during the measuring, the direction of the disposition and the center of the dipole potential reception remain fixed. "There are two main types of dispositions for the VES technique: Shlumberger and Wenner." (BRAGA, A. C. O., 2007).

In this study, we opted for the LOC technique. This technique is related to the resistivity, which is obtained by measurements of the analyzed surface location, investigating its horizontal variation confirming its depth. Therefore, the LOC is used more commonly in data acquisition for the mapping and plotting subsurface, since the resistivity of rocks and lithological materials as well as water and pollutant residues can be easily identified (MOREIRA et al., 2009).

It was used in this work the dipole-dipole array in which the depth of investigation depends directly on the electrode spacing in a way that Z is the depth of the investigated level, and R is the distance between the electrodes centers. Therefore we have Z = R / 2, where R is the distance between the centers of the dipoles in question (AB and MN). However, in practice, this relationship is seen with greater consistency if a the value of R is equal to approximately one quarter of the of the investigated depth.
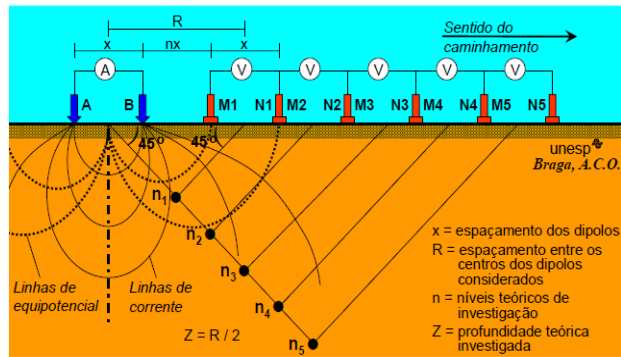
Picture 2: Arrangement Dipole-Dipole - EC. source: (BRAGA, A. C. O., 2007).

The expression used to calculate the apparent resistivity is:

$$\rho_a = k \frac{\Delta V}{I} \qquad (1)$$

Obtained through the stream of a current I, issued through two electrodes A and B and the potential difference ΔV, usually measured through the electrodes of said potential M and N. This makes it possible to obtain the apparent resistivity ρa.

$$k = \frac{2\pi}{\dfrac{1}{AM} - \dfrac{1}{BM} - \dfrac{1}{AN} + \dfrac{1}{BN}} \qquad (2)$$

Where k is a geometrical factor that depends on the distances between the electrodes (A and B) and on potential (M and N), I is the current generated between the electrodes and ΔV the potential difference established between M and N.

To implement the study, we used two foam filled tubes of PCV, with holes around their bases so they gradually allow the flow of ionized solution. After opening the trench, we used a piece of lining PCV (Figure 3) to divide the trench into two cells. One to receive ionized solution and the other common water, for comparison.

Picture 3: Preparation of the experimental site

The ditch was filled cobblestone (granite) and covered by soil material, predominantly composed of clay and the tubes positioned as shown in figure (3). Thereafter, delimitating your real area and placing four lines (sections) in parallel, with 0.25 m spacing between the electrodes, being able to map four levels of depth up to 0.5 m below ground. The tubes were prepared as shown in figure (4) and fixed in place.

Picture 4: Preparation of the tubes in the experiment

Using a source of alternating current of 20V and a calibrated multimeter on 200µA, was collected by means of the technique of LOC (dipole-dipole), a mesh of 94 measurements in the DOP containing results (Difference of potential), investigated for each line, arranged in four levels. After collecting and organizing data, we calculated the geometric factor and the apparent resistivity (ρa) at each point investigated to obtain the geo-electric pseudo sections.

Figure (5) shows the distribution pattern of the arrangement measure lines. Lines 1 and 4 are the external and lines 2 and 3 are central. The tubes through which saline solution was inserted are between the lines 2 and 3.
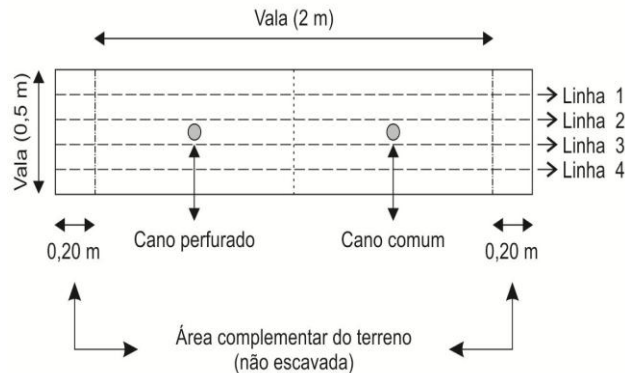
Picture 5: Schematic distribution of rows for performing measurements

After insertion of saline solution, 30 minutes have passed to carry out the first measurement. One hour later the second measurement was performed.

The results of geo-electric pseudo-sections of line 1 are shown in pictures 6a and 6b. It is observed that the value of the apparent resistivity decreases significantly between the two measurements as a result of diffusion of saline water infused into the tubes.

Figures (7a and 7b) show the results for the pseudo-geo-electric sections of the line 2 between the two time intervals and figures (8a and 8b) show the geo-electric pseudo-sections of line 3. One can observe a strong variation in the apparent resistivity between the two measurements, both in line 2 as line 3.

Figures (9a and 9b) show the result of line 4. This line showed the smallest variation between the measured values of the two time points.

The experiment described in this work indicates that the apparent resistivity is strongly affected by the presence of saline solution. Thus, the geo-electrical resistivity method, when applied by the technique of Laying of Cables, proved to be an excellent tool for conducting environmental monitoring. Therefore, the simulation showed in this paper can be used for the training of this excellent geo-physical technique.
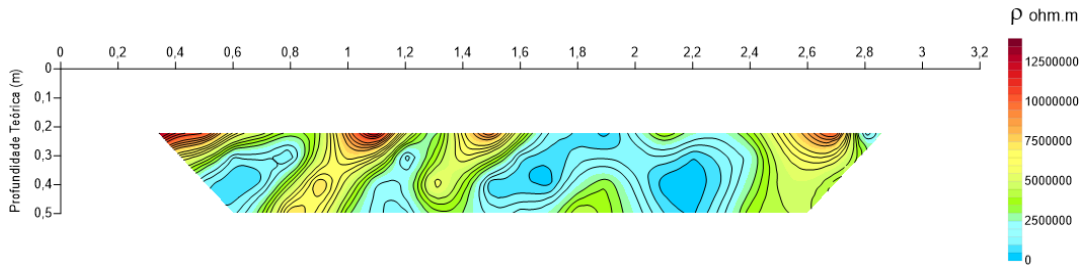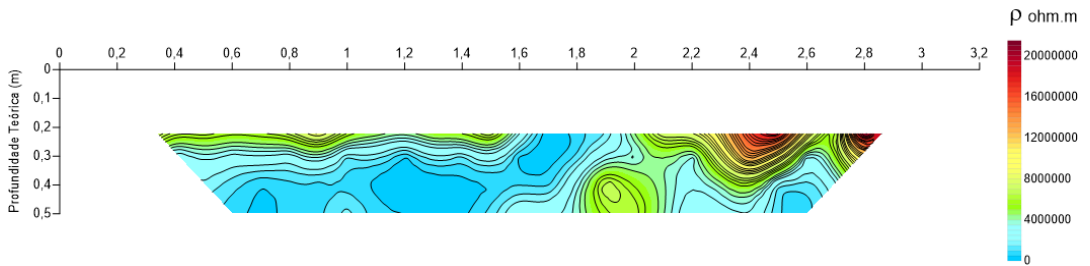

Picture 6a: Geo-electric pseudo-section of apparent resistivity in line 1 measured at 08:45.
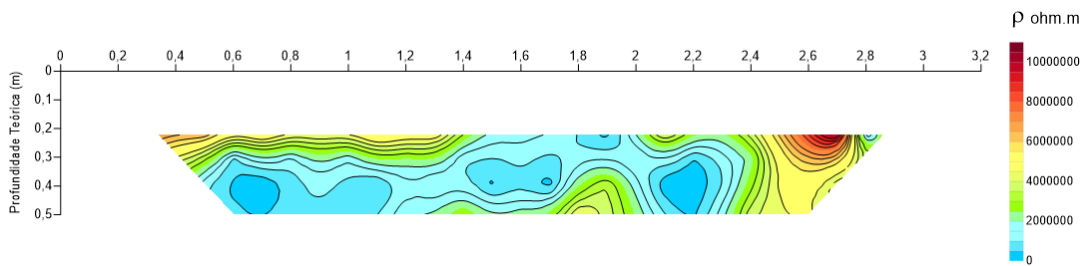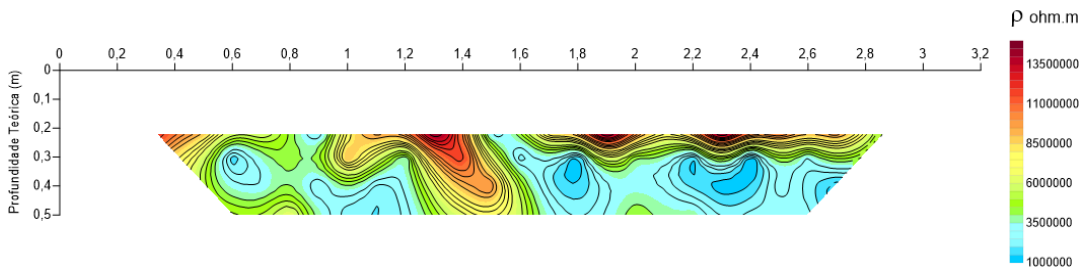

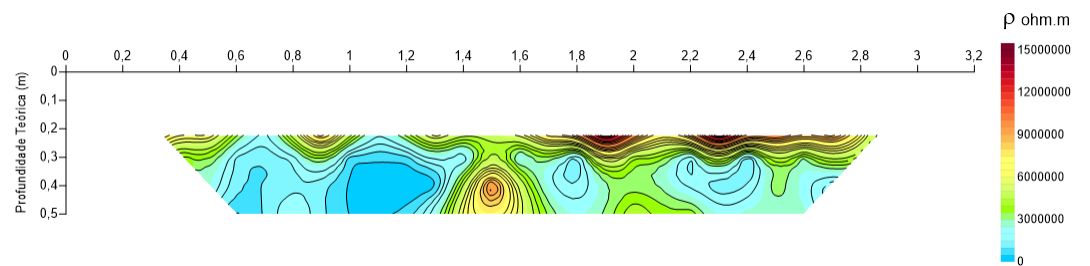**Picture 6b:** Geo-electric pseudo-section of apparent resistivity in line 1 measured at 09:45.
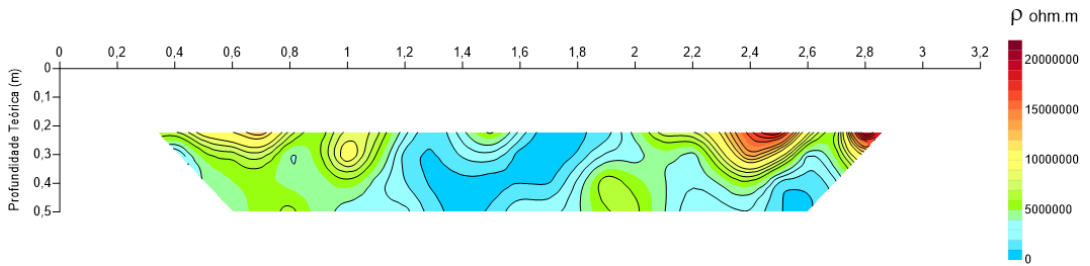
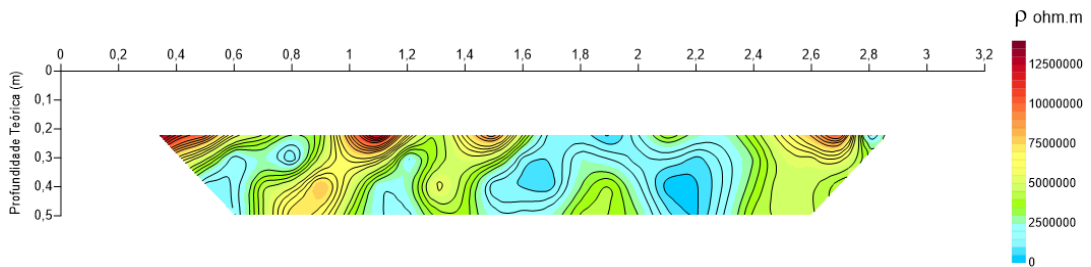**Picture 7a:** Geo-electric pseudo-section of apparent resistivity in line 2 measured at 08:45.

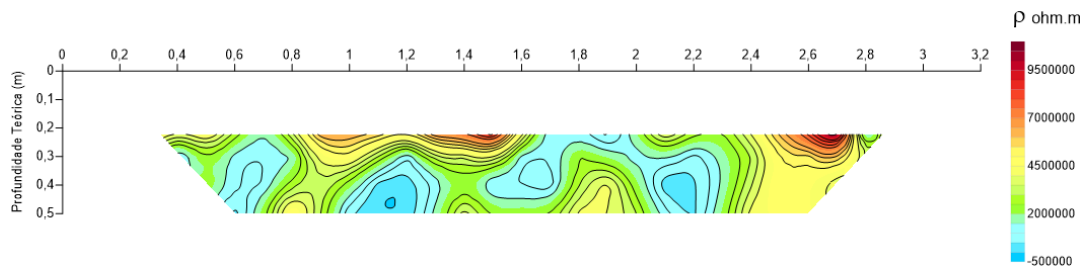**Picture 7b:** Geo-electric pseudo-section of apparent resistivity in line 2 measured at 09:45.

Picture 8a: Geo-electric pseudo-section of apparent resistivity in line 3 measured at 08:45.

Picture 8b: Geo-electric pseudo-section of apparent resistivity in line 3 measured at 09:45.

Picture 9a: Geo-electric pseudo-section of apparent resistivity in line 4 measured at 08:45.

Picture 9b: Geo-electric pseudo-section of apparent resistivity in line 4 measured at 09:45.

3.   ACKNOWLEDGEMENT

4.   REFERENCES

[1] BRAGA, A. C. O. Geofísica Aplicada – Módulo: Métodos Geoelétricos Aplicados nos Estudos de Captação e Contaminação das Águas Subterrâneas. (Applied Geophysics - Module: geo-electrical methods applied in studies of funding and Contamination of Groundwater). UNESP – Universidade Estadual Paulista (Paulista State University) "Julio de Mesquita Filho" – Rio Claro – 2007.

[2] GALLAS, J. D. F. et al. Contaminação por chorume e sua detecção por resistividade. (Contamination by leachate and its detection by resistivity). Revista Brasileira de Geofísica (Brazilian Journal of Geophysics), v. 23, n. 1, p. 51-59, jan./mar. 2005.

[3] MAGALHÃES JR., A.; MOREIRA, P. F. Eventos de "desequilíbrio morfodinâmico" na evolução da evolução geomorfológica de Minas Gerais – O caso de Teófilo Otoni/Caraí – Região Nordeste do Estado. (Events of "morphodynamic imbalance" in the geomorphological evolution of Minas Gerais - The case of Teofilo Otoni / Karai - Northeast State). – UFMG – Universidade Federal de Minas Gerais (Federal University of Minas Gerais) – *Geonomos – Vol. 6, nº 2, p.23 – 32; - 1998.*

[4] MOREIRA, C. A.; BRAGA, A. C. de O.. Anomalias de Cargabilidade em Aterro de Resíduos Sólidos Domiciliares (Chargeability anomalies in Household Solid Waste Landfill). Revista Brasileira de Geofísica (Brazilian Journal of Geophysics), Rio de Janeiro, v. 27, n.1, p. 55-62, jan./mar. 2009.

[5] MOREIRA, C. A.; BRAGA, A. C. de O.; FRIES, M.. Degradação de resíduos e alterações na resistividade elétrica, pH e Eh (Degradation of waste and changes in electrical resistivity, pH and Eh). Revista Brasileira de Geofísica (Brazilian Journal of Geophysics), Rio de Janeiro, v. 27, n.2, p. 283 – 293, abr./jun. 2009.