Analysis of urban waste disposal area in São Carlos-SP between 1995 and 2005.

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Abstract

São Carlos is a city of state of São Paulo that presents problems due to inadequate urban waste disposal. This activity started in 1979 and finished in 1996, in other words, approximately 17 years. During these years, it was deposited, mainly, domestic solid wastes in the sanitary landfill.

The study area is constituted by porous soils overlapping sandstones of Botucatu Formation, which presents disadvantageous characteristic for this purpose (sanitary landfill). Besides, this area is located on the biggest reservoir of groundwater of the world: the Guarani Aquiferous. Therefore, it becomes easy contaminating and polluting this groundwater, which the city of São Carlos is supplied.

The aim of this work is to analyze a waste disposal area between 1995 and 2005 in São Carlos-SP using resistivity method, which already has showed its efficiency for the study of similar cases.

It was observed that the contamination is active and constantly progressing, and there is a plume of contamination propagating on NW and vertical direction, and also this contamination is on vertical direction due to presence of a discontinuity under sanitary landfill.

Introduction

Nowadays, the protection of environment becomes a very important matter due to contamination that affects and threats human´s vital resources. Surface soil and groundwater are more affected resources due to anthropogenic activities, manly, for domestic solid wastes. Therefore, it is necessary to characterizing, analyzing and checking your behavior along of time of theses contaminated areas. Geophysical methods presented a very useful tool for application in these sites, because it allows determining many aspects concern to investigated subsurface area.

The Direct Current (DC) Resistivity is a geophysical method widely used for application in contaminated sites since 1960, Stollar et al (1975). According to Elis (1998) and Elis et al (1998), the DC resistivity method is the powerful tool to determine the horizontal and vertical discontinuities in the electrical properties of the ground, in the other words, depth and extension of this contaminated subsurface, and it is too a low cost and efficiency method.

The aim of this work is to analyze a waste disposal area between 1995 and 2005 in São Carlos-SP. This area is a collapse caused by undermining waters and was filled in domestic, nosocomial and industrial solid wastes during approximately 17 years (1979 to 1996). After this time, every waste was buried, see figure 1.

In 1988, city of São Carlos produced $2.2.10^6$ kg of waste/ month, or 470 g/person by day according to study of Gomes (1991).

The study area is constituted by porous soils overlapping sandstones of Botucatu Formation. Where it is located one part of Guarani Aquiferous, the biggest reservoir of groundwater of the world, with $1.15.10^6$ km^2 of surface according to Embrapa, it being 71% in Brazilian land, 19% in Argentinean land, 6% Paraguayan land and 4% Uruguayan land.

This area presents disadvantageous characteristic as little depth of the groundwater level, agent of oxidation matter organic employing an advanced process oxidative called photonelectrooxidation (FEO) Rodrigues (2008), high permeability sandstones, low capacity of cationic change of the landfill substratum and high potential of erosion. Therefore, it becomes easy contaminating and polluting this area.

The contamination is a consequence of decomposition of solid wastes by water and enzymes, which produces a dark liquid called leachate. This dark liquid is acid and usually transports a series of chemical and biological compounds can pollute the sources of superficial and/or groundwater according to Carvalho (2001).

Previous studies revealed there are contaminations and pollution of groundwater in this area, which is located the main source of water supplying of the city. Nowadays it indicates there is contamination on the horizontally and vertically direction.

Figure 1: Buried waste disposal area.

Method

The technique used to investigate this site was resistivity with dipole-dipole arrange and spacing of 10 m. The data was previously collected in two distinct periods: 1995 and 2005. Which it allow analyzing the behavior of the contamination source in this time range through the processed data by Res2dinv software.

Resistivity was performed through two transmitter electrodes inject direct electrical current into the ground, which it is constituted by different electrical proprieties (resistivity or conductivity) rocks, and the measures are made through by receiver electrodes. The transmitter and receiver electrodes have fixed spacing, AB and MN, respectively, and this arrange is dislocated with constant spacing along of soil profile, see the figure 2.

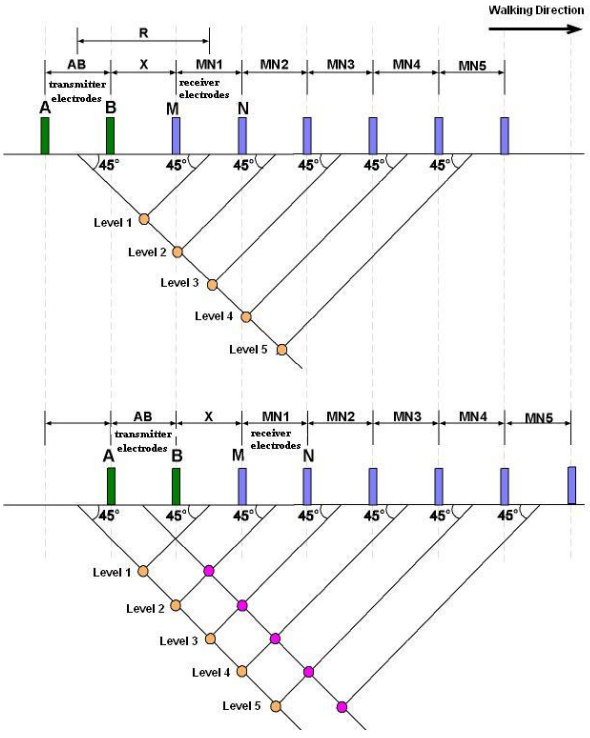

Figure 2: Layout of the electrodes arrange.

Results

The resistivity profiles were obtained through the Res2dinv software and are showed in figure 3, 4, 5 and 6.

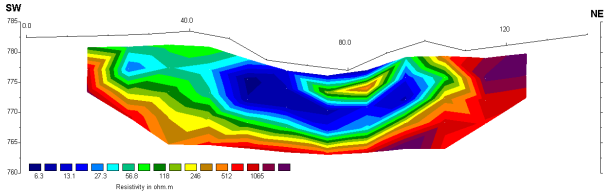

Figure 3: Resistivity profile 1 in 2005.

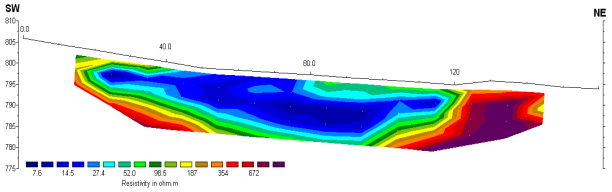

Figure 4: Resistivity profile 2 in 2005.

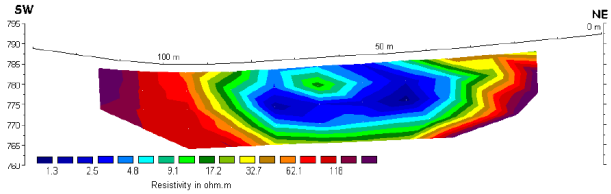

Figure 5: Resistivity profile 3 in 1995.

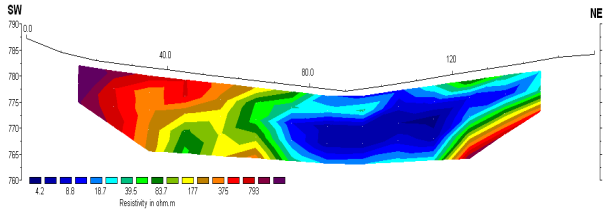

Figure 6: Resistivity profile 4 in 2005.

It can be observed that regions of resistivity in the profiles, between approximately 150 and 1000 Ω.m, are due to the sandstones of Botucatu formation, while regions of lower resistivity are due to compounds of contamination, since they present a bigger conductivity than the sandstones, see figures 3 and 4.

Analyzing resistivity profile 3 and 4 between 1995 and 2005, it is possible to observe that the contamination is active and constantly progressing. Another very important characteristic can be observed there is a plume of contamination propagating on NW direction, and also this contamination is on vertical direction due to presence of a discontinuity under sanitary landfill according to Velozo (2006). These effects were also observed by Gonçaves et al (1992) and Velozo et al (2006).

Conclusions

According to obtained results, the eletrorresistivity method was very useful for analyzing the contamination in an area of São Carlos-SP. It is possible to conclude that the urban waste disposal area still is contaminated by leachate, which it is active and constantly progressing.

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