Geoelectricals surveying in aluvional sediments of Madeira River (Porto Velho/RO)

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Abstract

The construction of two hydroelectric dams in Madeira River, near to Porto Velho city, will force the dredges, which explore residual gold in the stream bed, to change the location. The purpose of this work was to identify the auriferous conglomerate from Mucururu Formation using geophysical studies.

Vertical electrical soundings (VES) and continuous vertical electrical sounding (CVES) were done in pre-determined places by geologists. In total were done 52 VES and 9 lines of CVES.

After an integration of geophysical data and geological observation were determined the most propitious places to have this auriferous conglomerate. A borehole with lithological description is suggested in some points to a better calibration of the model.

Introduction

This expanded abstract describes the geophysical studies performed in Porto Velho city, in the margin of Madeira River. These geophysical studies, mainly geoelectrical methods, intended to identify a conglomerate layer, called Mucururu conglomerate, where disseminated gold occurrence.

The studies were developed on the months of July to September of 2010; in predetermined places chosen by geologists of CPRM/Porto Velho. Three targets along the margin of Madeira River were selected: Búfalo Island target, Liverpool Island target and Morrinhos target (figure 1).

In Madeira River there are many dredges (figure 2) that remove gold from its stream bed. With construction of two hydroelectric dams, Santo Antonio and Jirau, a new positioning of these dredges are necessary to explore the disseminated gold.

Figure 1: Localization of the studied area showing the three targets.

Figure 2: Dredge on Madeira River.

Method

In the geologic environment, the different lithogeologic types present a fundamental physical property: *the electrical resistivity parameter.* This property is related to some lithological features such as alteration, fracturing, saturation and even the rock identification.

An electric conductive rock can be considered as an aggregate with solid minerals, liquids and gases, in which the resistivity is influenced by the following factors:

1. Mineral's resistivity of solid rock;
2. Gases and Liquid's resistivities in the rock pores;
3. Rock's Humidity;
4. Rock's Porosity;

5. Rock's texture, formation and pores distribution;
6. Processes that occurs in the contact between the liquid in the pores and the mineral structure, such as, adsorption process and ions in the surface of the mineral skeleton, decreases the total resistivity of rocks.

In practice, the underground can't be considered a homogeneous environment and the electrical resistivity represents a weighted average of all true electrical resistivity in a volume of material, so the results calculation is an apparent resistivity (ρ_a).

The calculation of apparent resistivity (ρ_a) of the investigated environment can be calculated by the following equation:

$$\rho_a = K.\frac{\Delta V}{I}$$

where $K = 2\pi.\left(\frac{1}{AM} - \frac{1}{BM} - \frac{1}{AN} + \frac{1}{BN}\right)^{-1}$

In the figure 3 are present the average values of electrical resistivity of rocks and soils.

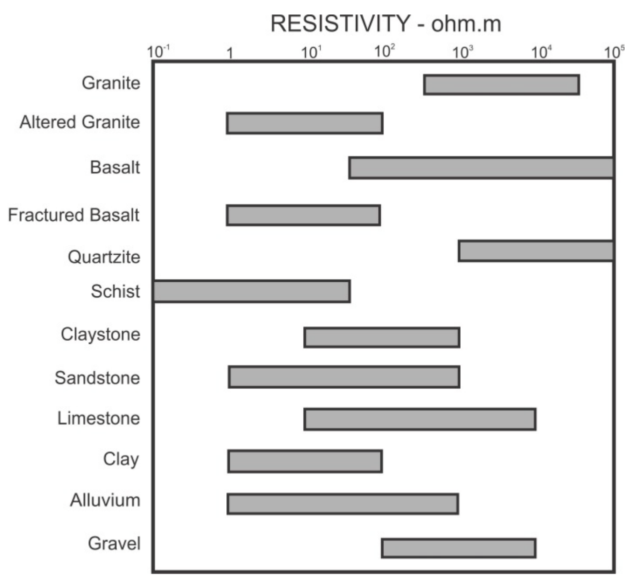

Figure 3: Electrical resistivity values of rocks and soil. Modified of Ward (1990).

The three mainly field techniques of geoelectrical methods are: vertical electrical soundings (VES), continuous vertical electrical soundings (CVES) and borehole (Figure 4). The differences among these techniques are the disposition of the electrodes on its surface or in the soundings hole.

VERTICAL ELECTRICAL SOUNDING (VES)	Vertically investigations of physical parameters variation with depth, makes on surface from a fixed point.
CONTINUOUS VERTICAL ELECTRICAL SOUNDING (CVES)	Laterally investigation of physical parameters, to one or more depths, makes on surface.
BOREHOLE	Vertically and laterally investigations of physical parameters, makes inside a soundings hole.

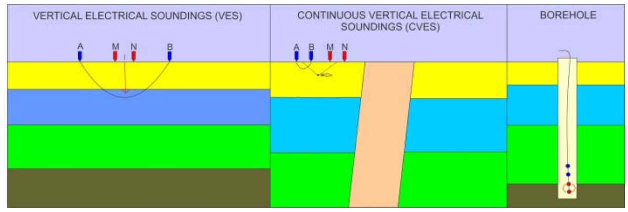

Figure 4: Techniques of geoelectrical methods.

The basic difference between a vertical electrical sounding and a continuous vertical electrical sounding is related to the investigation center, which depends on the AMNB electrodes configuration. While in the VES the array center AMNB doesn´t move, in the CVES the array center moves along the terrain surface during the acquisition.

Field data

For data acquisition was used the SISCAL-PRO from IRIS Instruments. This equipment can make until ten investigation levels when using CVES. In this studies were used six investigation levels with electrode spacing of 20 m for CVES and AB electrodes distance of 200 m in VES. These parameters were chosen because we had prior information about the depth of Mucururu conglomerate (about 15 to 20 m).

For modeling the VES data was used the software IPI2WIN (2000) from Moscow University and for CVES data inversion was used the software RES2DINV (2007) from Geotomo Software.

To obtain other parameters in VES results were done two experimental VES: at VES station 30 (near to construction site of hydroelectric) and at VES station 52 (near to abandoned mining). Near to construction site there is a borehole with profile geologic description. In this profile the Mucururu conglomerate isn't describe and there are only sandstone, clay and bedrock at 22 m of depth. After modeling, the VES station 30 presented values of resistivity below 100 Ω.m or greater than 1000 Ω.m.

The VES station 52 was done near an abandoned mining because the Mucururu conglomerate is outcropping in this place and its depth was approximately 10 to 12 m.

In the modeling of this station, at depth of 10.5 to 13.3 m there is a geoelectric layer with resistivity of 480 Ω.m. Duo to this fact and the table values obtained in literature, we assumed that the geoelectric layers with resistivity between 300 to 600 Ωm represents the Mucururu conglomerate.

Results

LIVERPOOL ISLAND TARGET

In this target were analyzed 11 VES stations (01, 02, 03, 04, 05, 33, 34, 35, 36, 37, 38) with distance of 200 m and two CVES lines: the line 1 (VES 01, 02, 03, 04, 05) and the line 6 (VES 33, 34, 35, 36, 37, 38). Figure 5 shows the localization of VES and CVES.

Figure 5: Localization of VES and CVES in Liverpool island Target.

Line 1

In this line there are five VES along 900 m of CVES. The results of CVES inversion and the identification of geoelectric layers with electrical resistivity between 300 and 600 Ω.m obtained of VES are showed in figure 6.

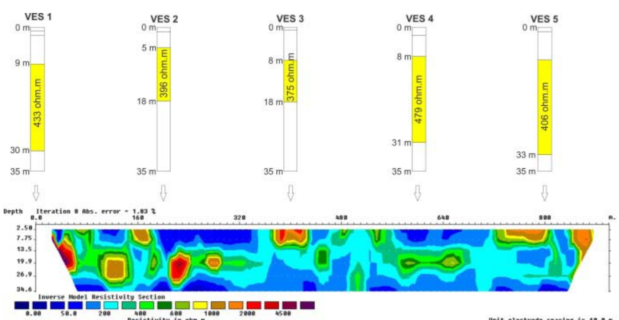

Figure 6: Results of CVES inversion (below) and result of VES (above) along profile.

The layer with electrical resistivity between 300 to 600 Ω.m doesn`t present a regular and continues form. But there are regions very well delimited with this electrical resistivity, located between 550 and 680 m in the profile. In the future a borehole can be made in this interval.

Line 6

In this line there are six VES along 1800 m of CVES. The results of CVES inversion and the identification of geoelectric layers with electrical resistivity between 300 and 600 Ω.m obtained of VES are showed in figure 7.

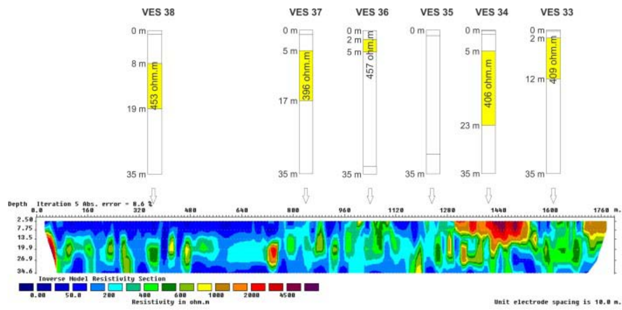

Figure 7: Results CVES inversion (below) and result of VES (above) along profile.

As for line 1, the range where the electrical resistivity varies between 300 to 600 Ω.m doesn't present a regular and continues form. The regions with higher probability to meet a Mucururu conglomerate are located between 800 to 1150 m and 1540 to 1700 m.

MORRINHOS TARGET

In this target were analyzed 22 VES stations (06, 07, 08, 09, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 53, 54, 55, 56, 57 and 58) with distance of 200 m and two CVES lines: the line 2 (VES 06, 07, 08, 09, 10, 11, 12, 13 and 14), the line 3 (VES 15, 16, 17, 18, 19, 20 and 21). Figure 8 shows the localization of VES and CVES.

Figure 8: Localization of VES and CVES in Morrinhos Target.

Line 2

In this line there are nine VES along 2500 m of CVES. The results of CVES inversion and the identification of geoelectric layers with electrical resistivity between 300 and 600 Ω.m obtained of VES are showed in figure 9.

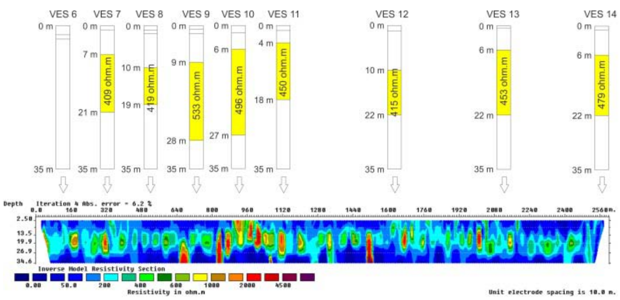

Figure 9: Results of CVES inversion (below) and result of VES (above) along profile.

The layer with electrical resistivity that represents values of 300 to 600 Ω.m has depth of 10 to 22m. But in some points in this depth, the values of electrical resistivity are higher, reaching 2.000 Ω.m. In this line, the regions more propitious to meet Mucururu conglomerate are located between 350 to 650 m and 1500 to 2500 m.

Line 3

In this line there are seven VES along 1250 m of CVES. The results of CVES inversion and the identification of geoelectric layers with electrical resistivity between 300 and 600 Ω.m obtained of VES are showed in figure 10.

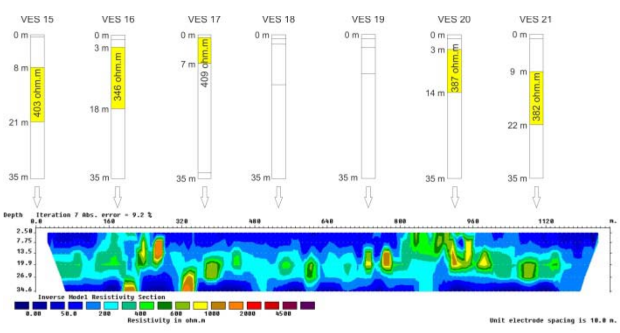

Figure 10: Results of CVES inversion (below) and result of VES (above) along profile.

The layer with electrical resistivity that represents values of 300 to 600Ω.m is more homogeneous, although this layer is not present at the VES stations 18 and 19. In the gap of 800 to 1150 m, this layer is homogeneous and continuous and it is near to surface between 800 to 960 m.

BUFALO ISLAND TARGET

In this target were analyzed 21 VES stations (22, 23, 24, 25, 27, 28, 29, 32, 39, 40, 41, 42, 44, 45, 46, 47, 48, 49, 50, 51 and 52) with distance of 200 m and five CVES lines: line 4 (VES 22, 23, 24, 25, 27, 28, 29), line 5 (VES 32), line 7 (VES 39, 40 and 41), line 8 (VES 42, 44, 45 and 46) and line 9 (VES 47, 48, 49 and 50). Figure 11 shows the localization of VES and CVES.

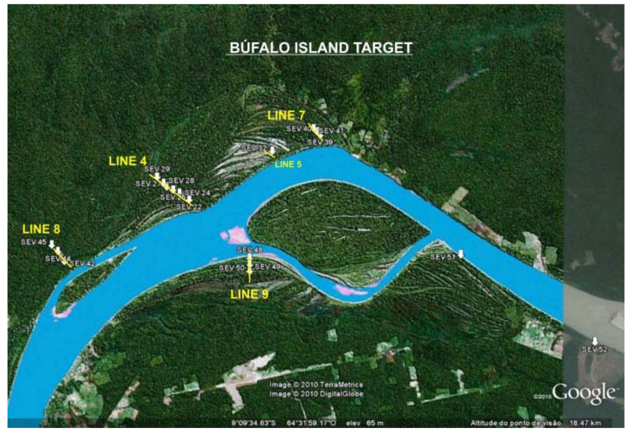

Figure 11: Localization of VES and CVES at Búfalo Island Target.

Line 4

In this line there are seven VES along 1800 m CVES. The results of CVES inversion and the identification of geoelectric layers with electrical resistivity between 300 and 600 Ω.m obtained of VES are showed in figure 12.

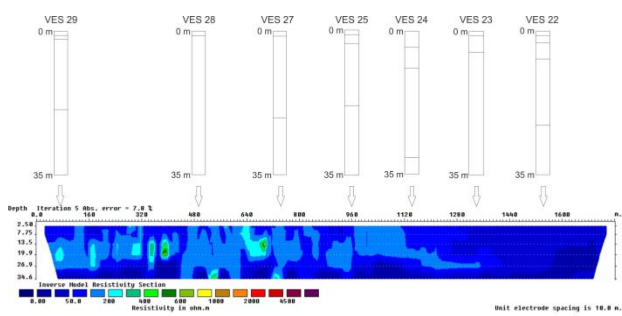

Figure 12: Results of CVES inversion (below) and result of VES (above) along profile.

This line did not present a gap of electrical resistivity between 300 and 600Ω.m . This fact indicates a minor possibility to meet a Mucururu conglomerate in this profile.

Line 5

In this line there is one VES along 300 m of CVES. The results of CVES inversion and the identification of geoelectric layers with electrical resistivity between 300 and 600 Ω.m obtained of VES are showed in figure 13.

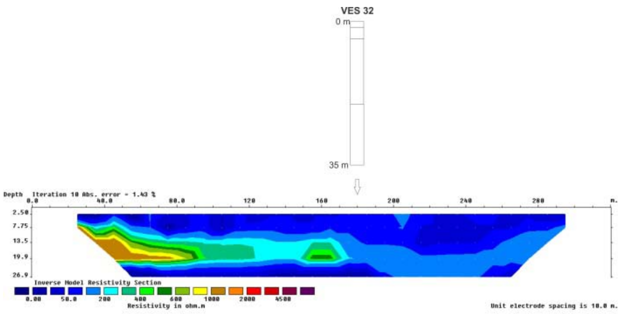

Figure 13: Results of CVES inversion (below) and result of VES (above) along profile.

This line presented a small gap between 80 and 170 m where the electrical resistivity was between 300 and 600 Ω.m. In this gap the depth of this layer ranged from 12 to 20 m.

Line 7

In this line there are three VES along 800 m of CVES. The results of CVES inversion and the identification of geoelectric layers with electrical resistivity between 300 and 600 Ω.m obtained of VES are showed in figure 14.

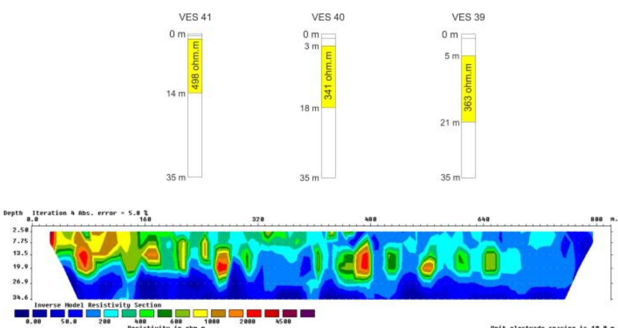

Figure 14: Results of CVES inversion (below) and result of VES (above) along profile.

This line indicated the presence of layer with electrical resistivity between 300 and 600 Ω.m with 5 to 20 m of depth, but this layer is not continuous and is disseminated in the profile.

Line 8

In this line there are three VES along 640 m of CVES. The results of CVES inversion and the identification of geoelectric layers with electrical resistivity between 300 and 600 Ω.m obtained of VES are showed in figure 15.

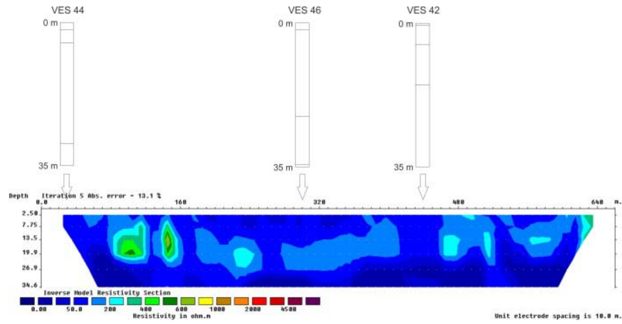

Figure 15: Results of CVES inversion (below) and result of VES (above) along profile.

As in the line 4, line 8 isn`t propitious to occur the Mucururu conglomerate. The exception is a little gap located between 80 and 160 m in the profile and with depth of 8 to 20 m.

Line 9

In this line there are four VES along 1100 m of CVES. The results of CVES inversion and the identification of geoelectric layers with electrical resistivity between 300 and 600 Ω.m obtained of VES are showed in figure 16.

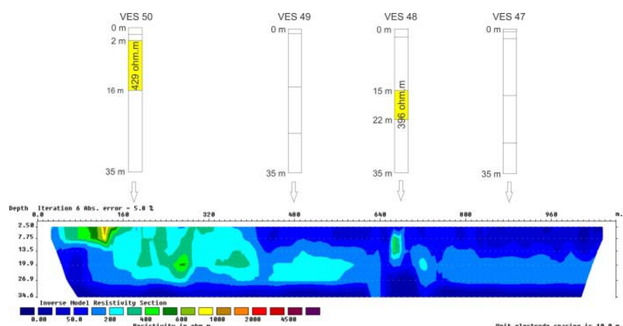

Figure 16: Results of CVES inversion (below) and result of VES (above) along profile.

The beginning of this line is favorable to Mucururu conglomerate; this layer is located near to surface with maximum depth of 10 m, but it is small and shallow.

Conclusions

One of the objectives of this expanded abstract was to verify the viability of the Mucururu conglomerate mapping in alluvial areas along Madeira River. Although without a borehole description of this conglomerate, there is an outcrop near an abandoned mining where it was possible to calibrate the value of its resistivity. Therefore we demonstrated that with geoelectrical method it was possible to determine places where the conglomerate is present and that the values of its resistivity vary between 300 and 600 Ω.m.

Analyzing the presence of Mucururu conglomerate in each target, we concluded that the Liverpool Island and Morrinhos targets are the most propitious to have the conglomerate. In target Búfalo Island, just the line 7 and a small gap in the line 5 are propitious to have this conglomerate.

In the Liverpool Island target, the gap where there is the Mucururu conglomerate is located between 550 and 680 m in the line 1. In the line 6 there are two gaps: 800 to 1150 m and 1550 to 1660 m in profile.

In the Morrinhos target, the gap where there is the Mucururu conglomerate is located in the intervals of 350 to 650 m and 1550 to 2500 m in the line 2 and in the line 3 there is a gap between 800 and 960 m in profile.

The results above presented reveal the need of achievements of geological borehole with lithological description in the places where geoelectrical studies indicated the presence of Mucururu conglomerate. This borehole will help to calibrate the geoelectrical models.

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