4.3 Geophysical Exploration

The purposes of the geophysical survey are composed of:

- To know Aquifer structure of the Study Area
- To know the depth of the distribution of Cretaceous aquifers

9) Method of Geophysical Exploration

Method for CSAMT

In this Study, CSAMT method was employed for geophysical survey. CSAMT (Controlled source audio magnetotelluric) method was employed for geophysical survey. CSAMT method is one of Electro-magnetic methods similar to MT (Magnetotelluric method). Transmitting frequency was changed in order to know the resistivity of different depth. In this Study, fourteen frequencies shown below were used to detect the geological structure up to 1,000 - 1,500m in depth.

Frequencies to be used in the CSAMT (Hz); 5120, 2560, 1280, 640, 320, 160, 80, 40, 20, 10, 5, 2.5, 1.25, 0.625

Observation Points

Observation points of CSAMT survey are shown in Figure-4.8. Observation points are grouped to 10 areas as described in the later of this section. In general there are many populated places in Bogotá Plain, which causes interruption to CSAMT exploration. Therefore, sites where CSAMT exploration can be available are limited in Bogotá Plain. The observation points shown in Figure-4.8 and have relatively good condition for CSAMT exploration.

10) Result of CSAMT Exploration

Method for Analysis

Apparent resistivity of the earth was calculated from electro-magnetic field which was observed in sites, One dimensional model was applied for sites of flat topography (A, B, C, D, E, G, H and I site), and two dimensional model was applied for sites of hilly topography (G, I site) to analyze topographical effect.

Result of Analysis

Result of CSAMT is shown in Figure-4.9 to Figure-4.11. Figure-4.9 shows the result of one-dimensional analysis, and Figure-4.11 show the two-dimensional analysis result. G site and I site with hilly topography were analyzed by both one- and two-dimensional analysis. The result of two- dimensional analysis is preferable for these sites. In interpretation of the CSAMT exploration results, criteria below are applied.

- Electric resistivity of Quaternary is less than 30 Ωm
- Electric resistivity of Tertiary is less than 50Ωm
- Electric resistivity of Cretaceous is more than 50Ωm

Of course, values of resistivity of geological formations are different even within the same formation, depending on content of clayey material and whether dry or saturated. Therefore, it is impossible to decide only one resistivity value for one specified formation. However, according to the existing geophysical results, it seems possible to apply the criteria for the Study Area. In this Study, the criteria are applied for interpretation of the CSAMT results. The result of CSAMT is explained below focusing on depth of Cretaceous Formations.

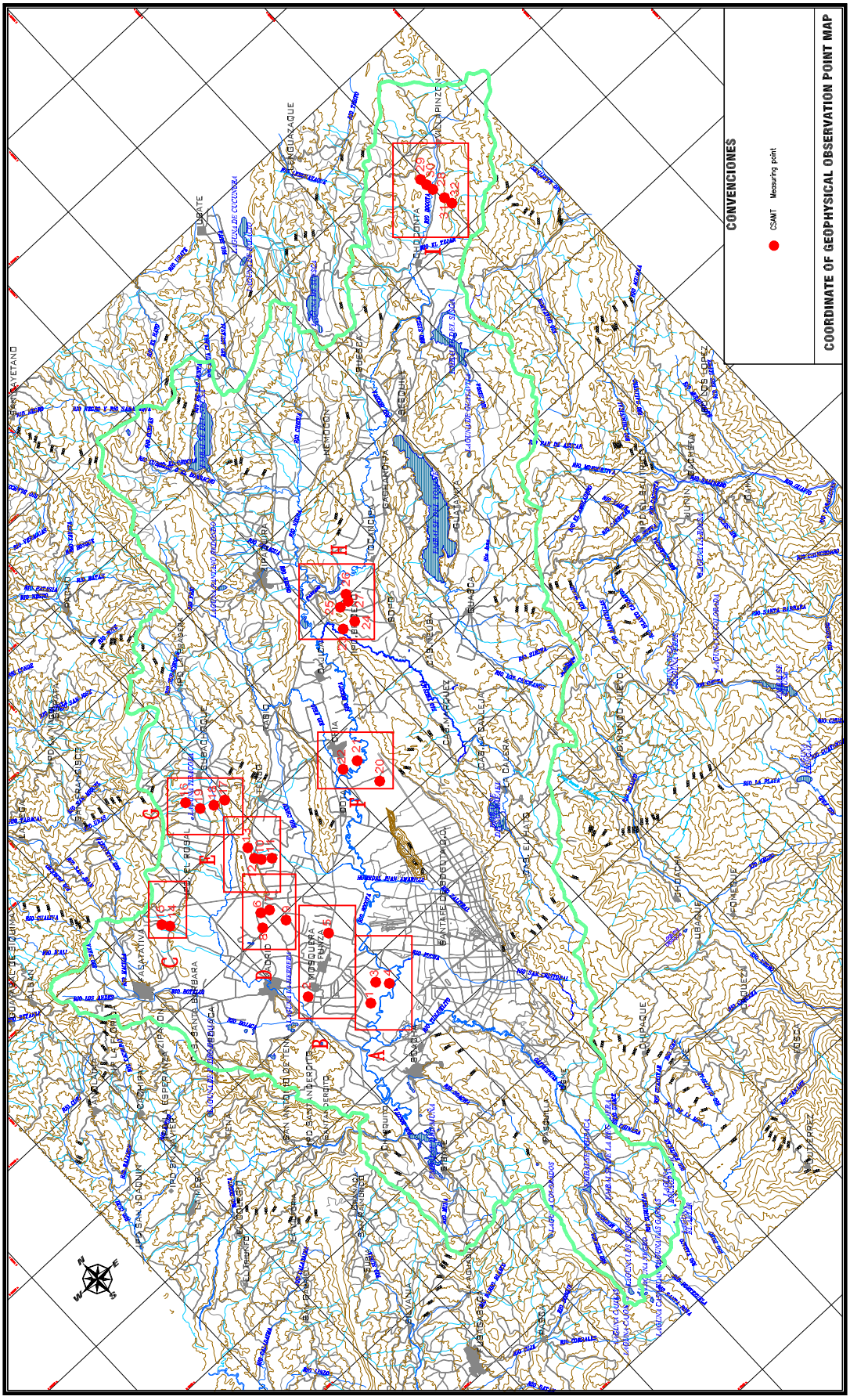

Figure-4.8 Site of CSAMT Exploration

A area (No.1, 3, 4)

According to the CSAMT result, formation with low resistivity of less than 10 Ωm is continuously distributes form GL-250 to at least GL-1,200m. This formation seems Tertiary and Quaternary. Therefore, it is assumed that Guadalupe Group distributes at least deeper than GL-1,200m.

B area (No. 2, 5)

According to the CSAMT results, formation with resistivity of around 10 Ωm continuously distributes from the ground surface up-to GL-400m, then again the formation with low resistivity of around 10Ωm continuously distributes from GL-400m to GL-1,000m. These formations seem Tertiary and Quaternary. Therefore, it seems that Guadalupe Group distributes at least deeper than GL-1,000m.

C area (No.14, 15)

According to CSAMT results, formation with high resistivity of 18-97 Ωm distributes continuously from GL-100m to deeper than GL-1,000m. This formation seems to be Quaternary at the top and after Guadalupe Group.

D area (No.6, 7, 8, 9)

According to CSAMT results, formation with high resistivity of 150 Ωm distributes between ground surface and GL-200m. This formation seems Guadalupe Group.

E area (No.10, 11, 12, 13)

According to CSAMT results, formation with high resistivity of more than 50 Ωm distributes from deeper than GL-200m. This formation seems Guadalupe Group.

F area (No.20, 21, 22)

According to CSAMT result, high resistivity formation of more than 80Ωm distributes with thickness of more than 1,000m. This formation seems Guadalupe Formation. Existing geological map shows that sinking of Cretaceous formation related to fault activity. CSAMT result shows that sinking depth seems around 250m.

G area (No.16,17,18,19,)

According to CSAMT result, formation with high resistivity of 200Ωm distributes from GL-100～GL-400m in both side of Subachoque River plain. This formation seems Quaternary Formation. Underlying formation with resistivity of 5 -50Ωm seems Guadalupe Formation. Upper part of Quaternary and Tertiary Formation, from GL-100m to -300m, shows high resistivity of 10～100 Ωm. This part seems sand and gravel. Fault may exist in hills running the right bank side of Subachoque River (see Figure 4.7).

H area (No.23, 24, 25, 26)

According to CSAMT result, formation with resistivity of 13～25 Ωm distributes deeper than GL-100m. This formation seems Guadalupe Formation. Resistivity of Guadalupe Formation of this site becomes 11～42Ωm from GL-400m to the deep part of the ground.

I area (No.28, 29, 30, 31)

According to CSAMT result, formation with low resistivity of 50 Ωm continues to deep part of the ground. Formation with resistivity of 20-50Ωm distributes deeper than GL-400m. This formation seems Guadalupe Formation. Geological structure by fault activity is recognized in

both sides of valley (see Figure-4.11).

(3) Conclusion of CSAMT Survey

According to the CSAMT results, the top of Guadalupe Group distributes at least deeper than GL-1,000m or GL-1200m in the center of Bogotá Plain. Then the top of Guadalupe Group distributes gradually nearer to the ground surface toward the border of the Study Area. This result corresponds to result of the existing study.

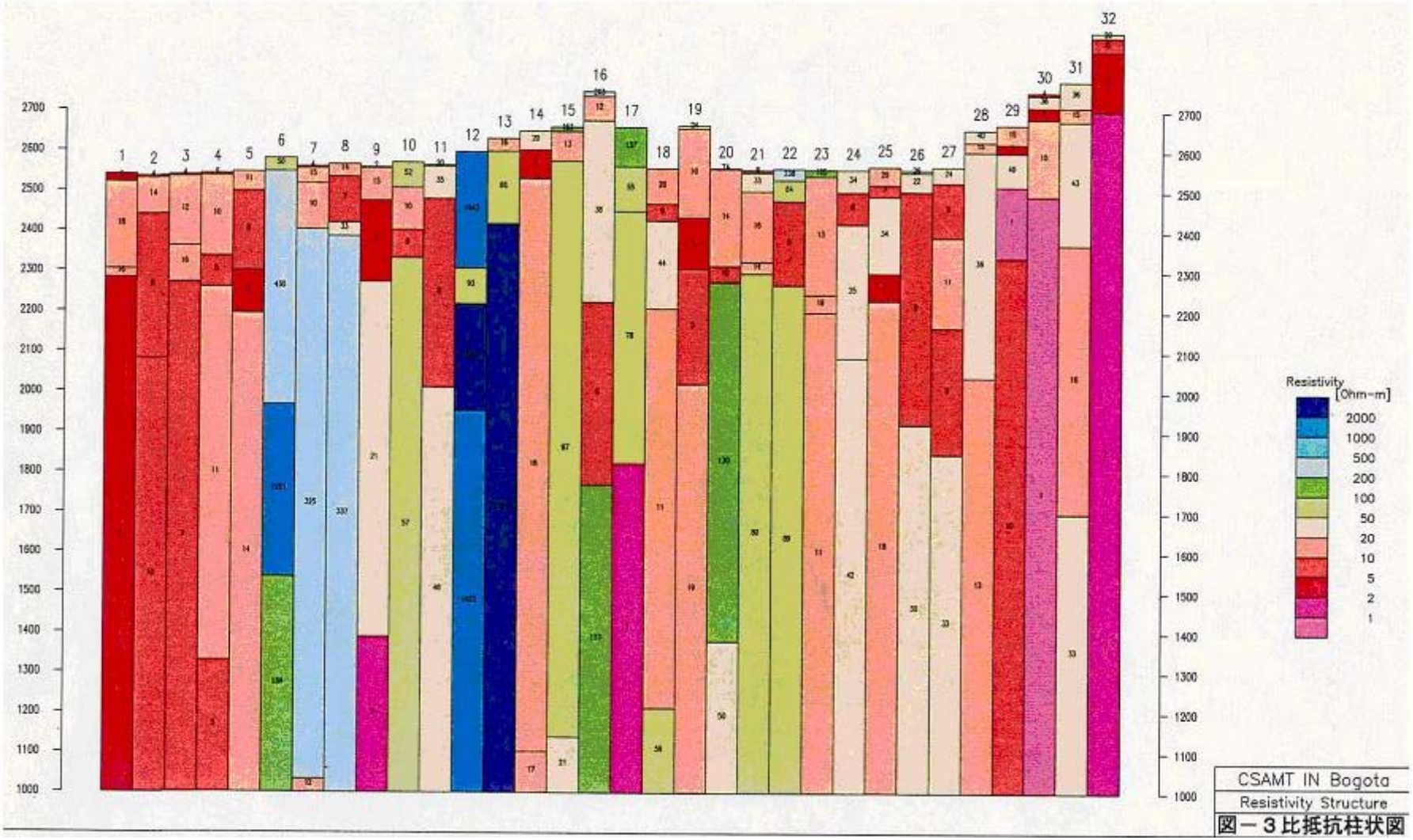

Figure-4.9 Result of One-dimensional CSAMT Analysis（All Area）

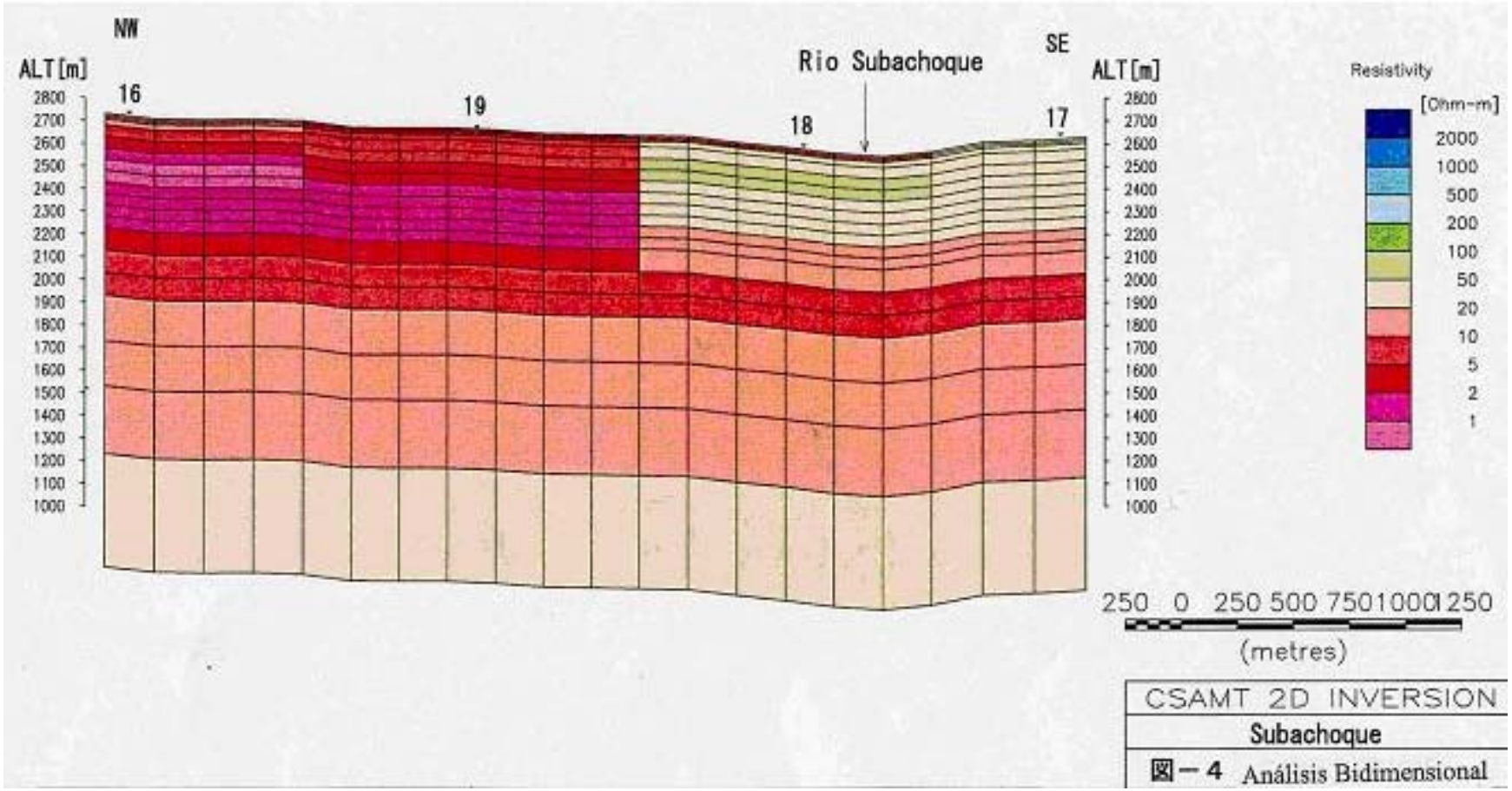

Figure-4.10 Result of Two-dimensional CSAMT Analysis (G Area)

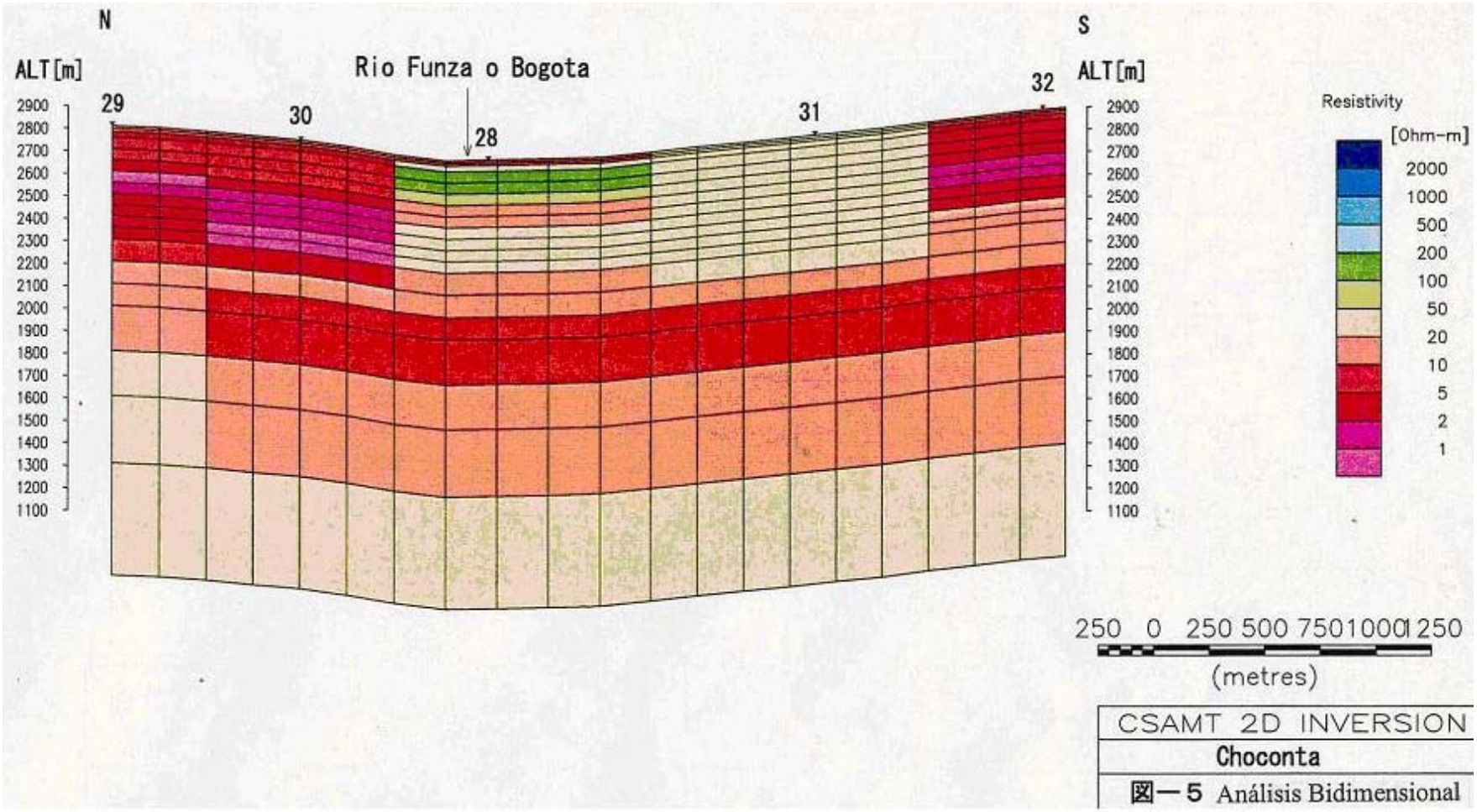

Figure-4.11 Result of Two-dimensional CSAMT Analysis（I Area）