Detection of Fractured Basaltic Bodies for Aquifer Characterization in South Central Panama using 2D Electrical Resistivity Imaging

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1. Introduction

Studies of altered intrusive bodies can play an important role in understanding the hydrogeological potential of a given area in the Panamanian tropics. In the central region of Panama (Central America), the climatic conditions during the dry season make access to drinking water difficult, which is necessary for agriculture, livestock and daily human activities. The Estibaná sub-catchment is a rural, seasonally dry area, located in South-Central Panama. The thickness of the weathered/fractured mantle rock controls the characteristics of the aquifers (Acworth, 2001).

Obtaining information on the spatial distribution of this type of geological formations through geo-technical tests could be complex; in this context, geophysical methods can play an important role.

Figure 1 (left) shows the Estibaná sub-catchment in the Isthmus of Panama and at (right), the VC site.

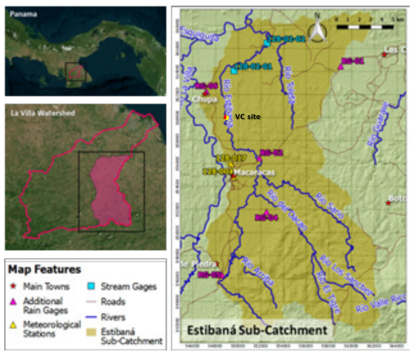

Figure 1. Location of the study area within Panama, Central America.

2. Geological context

The study area is located in the intermediate zone of the Estibaná sub-catchment. Volcano-sedimentary sequences have been identified in this area, where sandstones and shales predominate. Agglomerates are also present, fractured on the beds of streams and rivers (Ruíz, 2018).

On the surface, volcanic, volcano-clastic rocks predominate, followed by sedimentary rocks deposited in valleys or depressions.

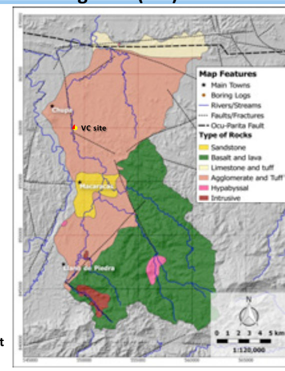

Figure 2. Geology of the Estibaná sub-catchment (adapted from Ruíz, 2018).

3. Geological cross-section of the VC site

The VC site is dominated by a relatively flat topography with very few prominent elevations where geological features make up the core of the Macaracas valley - plain. In addition to the body of agglomerated basalts, a dike with an azimuth orientation of 100° is defined. On the right bank of the Estibaná River there is an outcrop of the same agglomerated basalt in contact with a crystallized volcano-sedimentary sequence with an azimuth orientation of 120°. Figure 3 shows the geological cross-section of the site.

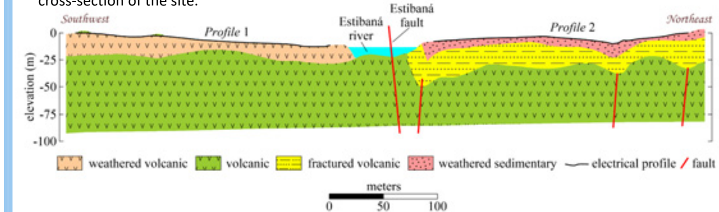

Figure 3. Geological cross-section of the VC site, Estibaná sub-catchment.

4. Methods and materials

Two profiles of 235 m long each were defined (Figure 4a). The apparent electrical resistivity data was obtained through use of a multi-electrode device (Syscal R1) switch-48 connected to 2 multi-cable systems with 24 outputs each, allowing a linear arrangement of a total of 48 electrodes with a maximum electrode spacing of 5 m (Figure 4(b)). The data were inverted using the BERT Code (Boundless Electrical Resistivity Tomography), see Günther *et al*., (2006), which is based on the establishment of an unstructured tetrahedral mesh and on the finite element method for forward calculation (Rücker *et al*., 2006).

(a) (b)

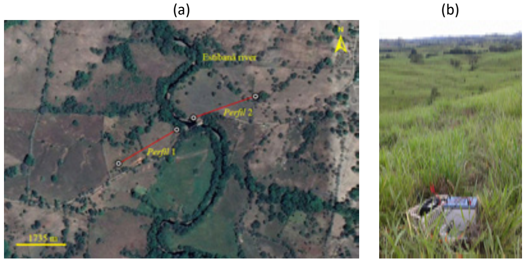

Figure 4. (a) Map showing the location of electrical profiles in VC site and (b) Syscal R1 switch-48 used in this study.

5. Data interpretation and results

5.1 Electrical Resistivity Tomography results

The resolution of inverse problem for these electrical profiles of 235 m long are showed in Figure 5.

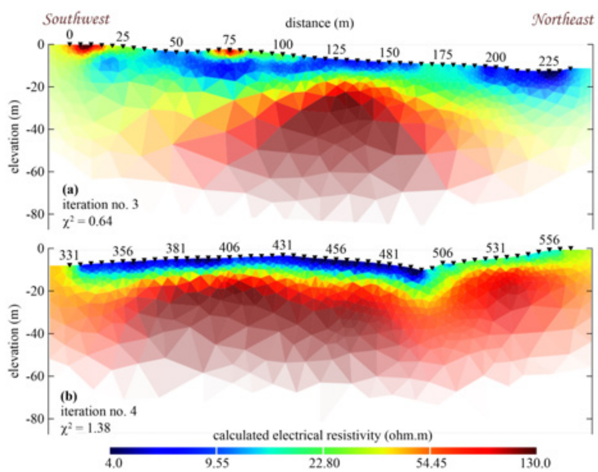

Figure 5. Electrical resistivity tomography performed across profiles (a) 1 and (b) 2. Inverted triangles represent the electrodes.

5.2 Forward modeling

A set of synthetic apparent electrical resistivity values were generated using theoretical subsurface electrical resistivity distribution models developed for profiles 1 and 2 (see Figure 6).

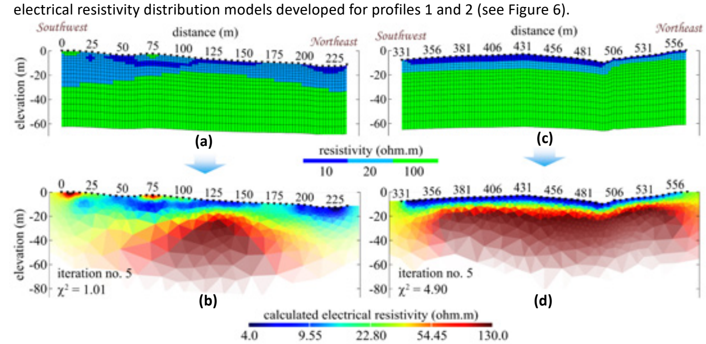

Figure 6. Synthetic reference models for Profiles (a) 1 and (c) 2 with 100 ohm.m (volcanic), weathered and fractured volcanic (20 ohm.m) and weathered sedimentary (10 ohm.m), and inversion process results of these theoretical models for Profile 1 (b) and 2 (d).

Acknowledgments

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