Journal of Applied Geophysics 76 (2012) 102–108

Contents lists available at SciVerse ScienceDirect

Journal of Applied Geophysics

journal homepage: www.elsevier.com/locate/jappgeo

TDEM survey in urban environmental for hydrogeological study at USP campus in São Paulo city, Brazil

Jorge Luís Porsani [a,*], Cassiano Antonio Bortolozo [a], Emerson Rodrigo Almeida [a], Esther Novais Santos Sobrinho [a], Thiago Gomes dos Santos [b]

[a] Universidade de São Paulo (USP), Instituto de Astronomia, Geofísica e Ciências Atmosféricas (IAG), Departamento de Geofísica, Rua do Matão, 1226, Butantã, 05508-090, São Paulo, Brazil
[b] Geophysicist (IAG/USP), Geosoft, Brazil

ARTICLE INFO

Article history:
Received 8 April 2011
Accepted 6 October 2011
Available online 13 October 2011

Keywords:
TDEM
São Paulo Sedimentary Basin
Hydrogeology
IAG/USP Test Site
São Paulo City
Brazil

ABSTRACT

In this work, some TDEM (Time Domain Electromagnetic) results at USP (*University of São Paulo*) *campus* in São Paulo city, Brazil, are presented. The data were acquired focusing on two mains objectives: (i) to map geoelectrical stratigraphy of São Paulo sedimentary basin, emphasizing on hydrogeological studies about sedimentary and crystalline aquifers, and (ii) to analyze the viability of TDEM data acquisition use in urban environment. The study area is located in São Paulo basin border, characterized by Resende and São Paulo formations, which are constituted by sand-clays sediments over a granite-gneissic basement. Two equipments were used in order to acquire database: Protem47 (low power), and Protem57-MK2 (high power). Capacitive noise affect obtained data with Protem47 due to the presence of metal pipes buried at IAG/USP (Institute of Astronomy, Geophysics, and Atmospheric Science) test site at USP. On the other hand, capacitive noise did not affect acquired data with Protem57-MK2, and the data present high signal to noise ratio. Surveys helped in determining sedimentary and crystalline aquifers, characterized by a fracture zone with water inside basin basement (conductive zone). Results show good agreement with local geology obtained from lithological boreholes located in the study areas. Moreover, it shows that TDEM method can be used in urban environments with a countless potential in hydrogeological studies, offering great reliability. Studies showed that main TDEM-method limitation at USP was the lack of space for opening the transmitter loop. Results are very promising and open new perspectives for TDEM-method use in urban environments as this area remains unexplored.

1. Introduction

TDEM (Time Domain Electromagnetic) method emerged in the mid 80's with the need to deeply explore regions with little resistive layers, since other electromagnetic methods using frequency domain were not able to accomplish these investigations with good resolution (Christiansen et al., 2006). The history of TDEM application shows that TDEM is a reliable method, once data interpretation is usually in agreement with geological information obtained of groundwater exploration boreholes.

Several researchers have successfully used TDEM method in hydrogeology, geothermal studies, mineral exploration, environmental studies etc. (Christiansen et al., 2006; Fitterman and Stewart, 1986; Hallbauer-Zadorozhnaya and Stettler, 2009; Jens et al., 2003; Land et al., 2003; McNeill, 1994; Sørensen et al., 2003, among others). However, there are no more than few studies about its application in Brazil (Bortolozo et al., 2010; Carrasquila and Ulugergerli, 2006; Lucena et al., 2009; Morais and Menezes, 2005; Porsani et al., 2010a; Santos and Porsani, 2007). For that reason, further studies are required to aim hydrogeological ones in Brazilian soils, taking into consideration the country's great hydric potential. Besides, geophysical studies are usually conducted in environments far from urban centers in order to avoid data contamination by electromagnetic noise. Consequently, the challenge for the 21st-century geoscientists is to perform geophysical surveys in urban areas with high electromagnetic noise level. Until now, there are no records in the literature using TDEM method in urban environment. As a result, it still remains as an unexplored area.

Aiming at contributing to apply TDEM-method research in urban areas, this work presents results of some practical experiments surveyed at USP (*University of São Paulo*), in São Paulo city, Brazil (Fig. 1). Studies have had two objectives: (i) to map the distribution of electrical resistivity of several São Paulo sedimentary basin portions, with emphasis on mapping sedimentary and crystalline aquifers for hydrogeological exploration, and (ii) to analyze the viability in using TDEM data acquisition in urban environment inside USP with huge electromagnetic noise and several structures that may affect the sounding with some coupling effects, usual in large worldwide cities.

* Corresponding author.
E-mail address: porsani@iag.usp.br (J.L. Porsani).

0926-9851/$ – see front matter © 2011 Elsevier B.V. All rights reserved.
doi:10.1016/j.jappgeo.2011.10.001

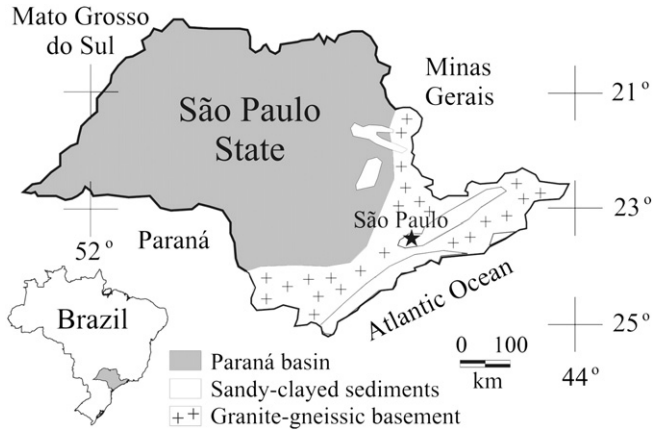

Fig. 1. São Paulo city location map, São Paulo State, Brazil.

TDEM survey allows mapping the distribution of electrical rock resistivity in subsurface related to decay of electromagnetic field propagated to subsurface. Physical and mathematical TDEM-method principles are based on Maxwell equations (Christiansen et al., 2006; Nabighian and Macnae, 1988, among others). For data acquisition, Protem47 (Geonics, 1994) and Protem57-MK2 (Geonics, 1998) equipments were used, making use of vertical electromagnetic sounding technique.

TDEM-station interpretation at USP was based on lithological information from boreholes used to explore groundwater, available near stations. Lithological information was used to check inversion results, and in this way to provide greater reliability in result interpretation. Results considered interesting are presented and discussed in this article.

2. Hydrogeological setting

USP *campus* is located on São Paulo sedimentary basin border, and it is constituted by sandy-clay sediments of Tertiary age (Resende and São Paulo formations), over Precambrian granite-gneissic basement. According to Iritani (1993), hydrogeological context can be divided in two distinct aquifer systems: a sedimentary and a crystalline aquifer. This one is characterized by fracture zones in granite-gneissic basement usually filled with water. Sedimentary aquifer has greater potential for groundwater exploration and holds crucial importance for São Paulo city, due to river and lake pollution. Lithological information from three boreholes used in geological-geophysical research drilled close to IAG/USP test site showed that the basement start in ~53 m depth. Fig. 2 shows lithological description and normal 64″ resistivity profiling from borehole-1. For resistivity profiling measurement, Welmac Sweden equipment (Mala Geoscience) was used. Observe that sedimentary pack is characterized by sandy-clay intercalations, and granite-gneissic basement is characterized by a fracture zone usually filled with water. These characteristics are the same ones found in two other boreholes. Once it

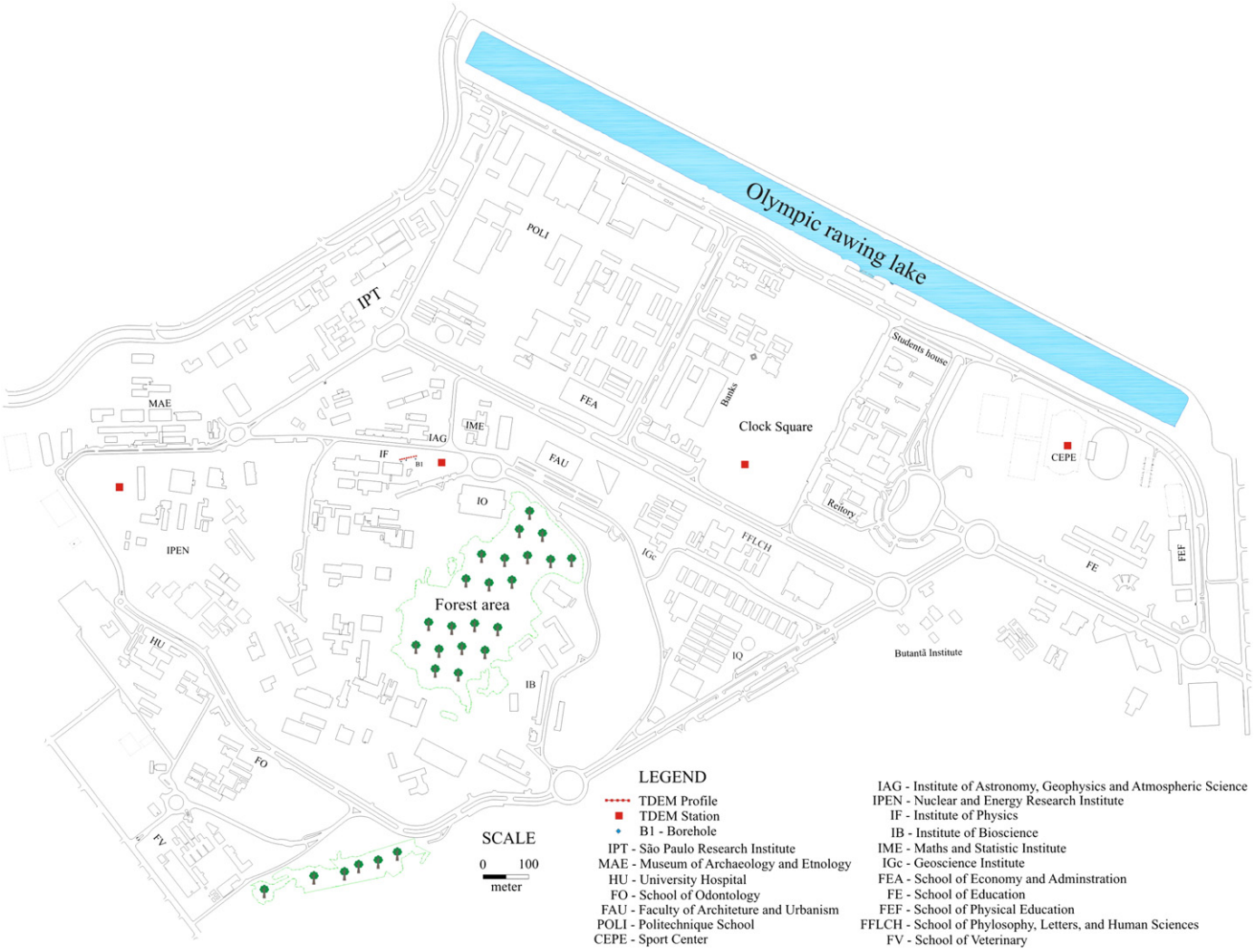

Fig. 2. Location of TDEM station as well boreholes for groundwater exploitation at USP *campus*, in São Paulo city.