ARTICLE IN PRESS

NRIAG Journal of Astronomy and Geophysics xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

NRIAG Journal of Astronomy and Geophysics

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

Full length article

Use of electromagnetic–terrain conductivity and DC–resistivity profiling techniques for bedrock characterization at the 15th-of-May City extension, Cairo, Egypt

Said A. Aly[a], Karam S.I. Farag[a], Magdy A. Atya[b], Mohamed A.M. Badr[a,*]

[a] Geophysics Department, Faculty of Science, Ain Shams University, Abbassia 11566, Cairo, Egypt
[b] National Research Institute of Astronomy and Geophysics (NRIAG), Helwan 11721, Cairo, Egypt

ARTICLE INFO

Keywords:
Multi-spacing electromagnetic–terrain conductivity meter and DC–resistivity horizontal profiling survey
Bedrock geology
Eastern extension of 15th-of-May City
Cairo
Egypt

ABSTRACT

A joint multi-spacing electromagnetic–terrain conductivity meter and DC–resistivity horizontal profiling survey was conducted at the anticipated eastern extensional area of the 15th-of-May City, southeastern Cairo, Egypt. The main objective of the survey was to highlight the applicability, efficiency, and reliability of utilizing such non-invasive surface techniques in a field like geologic mapping, and hence to image both the vertical and lateral electrical resistivity structures of the subsurface bedrock. Consequently, a total of reliable 6 multi-spacing electromagnetic–terrain conductivity meter and 7 DC–resistivity horizontal profiles were carried out between August 2016 and February 2017. All data sets were transformed–inverted extensively and consistently in terms of two-dimensional (2D) electrical resistivity smoothed-earth models. They could be used effectively and inexpensively to interpret the area's bedrock geologic sequence using the encountered consecutive electrically resistive and conductive anomalies. Notably, the encountered subsurface electrical resistivity structures, below all surveying profiles, are correlated well with the mapped geological faults in the field. They even could provide a useful understanding of their faulting fashion. Absolute resistivity values were not necessarily diagnostic, but their vertical and lateral variations could provide more diagnostic information about the layer lateral extensions and thicknesses, and hence suggested reliable geo-electric earth models. The study demonstrated that a detailed multi-spacing electromagnetic–terrain conductivity meter and DC–resistivity horizontal profiling survey can help design an optimal geotechnical investigative program, not only for the whole eastern extensional area of the 15th-of-May City, but also for the other new urban communities within the Egyptian desert.

1. Introduction

The 15th-of-May City is a distinctive suburban area at the southeastern Greater Cairo established in 1978. The Egyptian New Urban Communities Authority (NUCA) has been targeting to solve the Cairo's insufficient accommodation problem by expanding the surrounding residential areas connected to Cairo. The anticipated eastern extensional area of the 15th-of-May City is roughly centered at latitude 29°49′1.75″N and longitude 31°24′40.20″E, covering an area of some 8.85 km^2 (Fig. 1). It has an uneven topography, comprising several terraces reaching about 350.0 m above the sea level. Existing relative elevation differences within the area are ranged between 10 and 50 m (Fig. 2b).

The area's bedrock geology is made up, from the top (recent) to bottom (old) (Figs. 1 and 3), of the followings; (1) the surficial Late Quaternary Wadi deposits, composed mainly of pale yellow/yellowish brown, loose, fine-grained sand and gravel (in granule and pebble sizes) with little/traces of salty/calcareous/gypseous silt and iron oxides. Such thin deposits were developed in very shallow elongated depressions or drainage channels, in the form of small-scale Wadi terraces, fans, and fillings, and could be delivered at the short time spans of annual floods and heavy rains from the adjacent eastern mountainous region; (2) the Upper Eocene Qurn Formation, composed mainly of yellowish white, medium hard, cavernous, Nummulitic, limestone, marl/marly limestone and chalk/chalky limestone with thin dolomite and gypsum bands (Strougo, 1985; Said, 1990). The outcropped thickness is averaged as 65.0 m; and (3) the Middle Eocene Observatory Formation, composed mainly of white/pale yellowish white, fractured,

Peer review under responsibility of National Research Institute of Astronomy and Geophysics.
* Corresponding author.
E-mail address: m_abdeldayem@sci.asu.edu.eg (M.A.M. Badr).

https://doi.org/10.1016/j.nrjag.2018.03.005
Received 13 October 2017; Received in revised form 14 February 2018; Accepted 15 March 2018

Please cite this article as: Aly, S.A., NRIAG Journal of Astronomy and Geophysics (2018), https://doi.org/10.1016/j.nrjag.2018.03.005

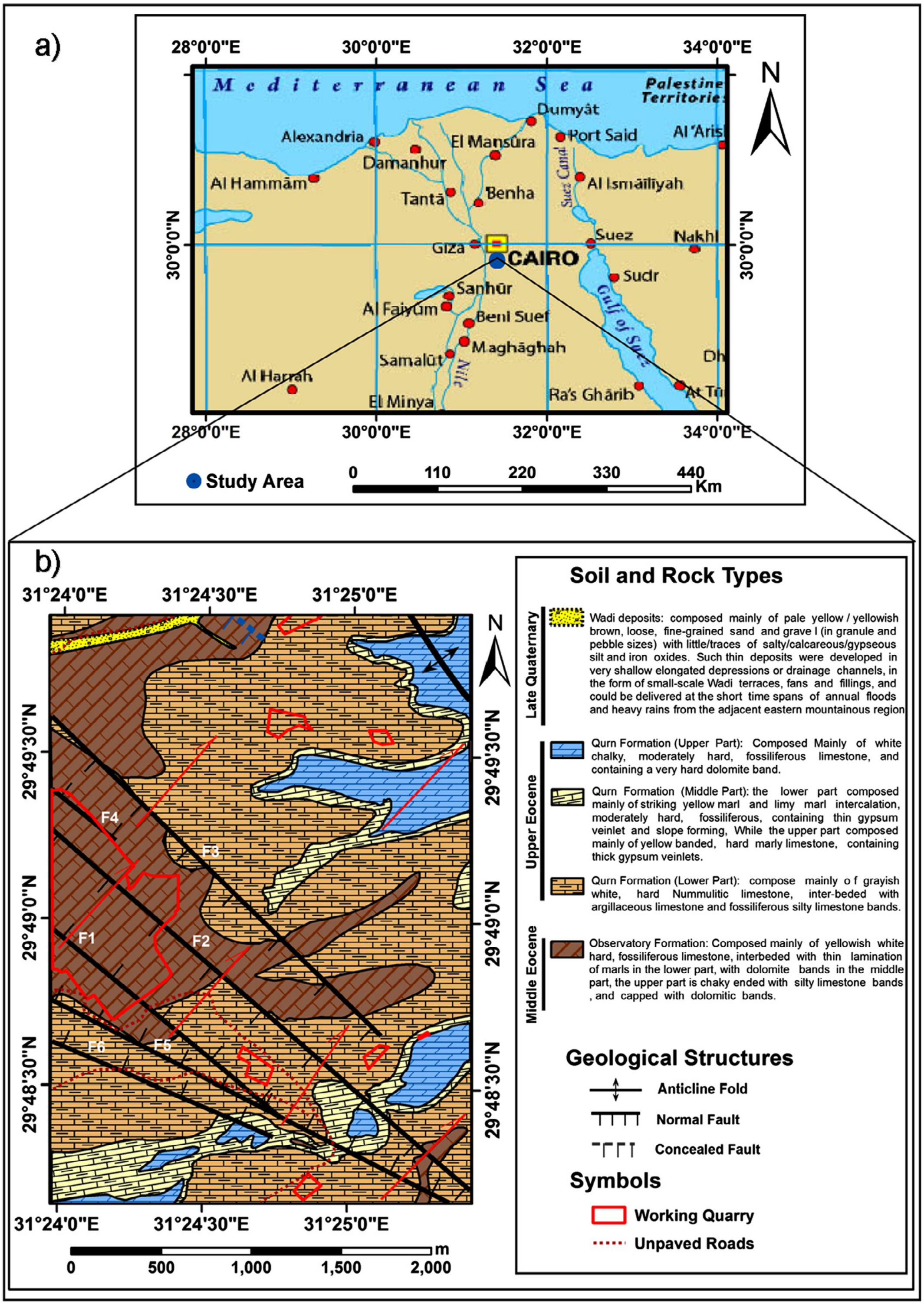

Fig. 1. (a) General location and (b) detailed surface geologic maps of the eastern extension of 15th-of-May City, southeastern Cairo, Egypt. The bedrock geology has been constructed based on LANDSAT–TM satellite imagery, aerial photography, surveyed topography and several collected stratigraphic sections using high-resolution global positioning system (GPS) surveying records.

fossiliferous, hard limestone with thin marly limestone and dolomite bands. The outcropped thickness is averaged at 75.0 m, while its total thickness can reach 100.0 m (Mohamed et al., 2012). The area is dissected and transacted by four sets of complex normal faults, trending mainly northwest–southeast. Additionally, its subsurface bedrock is affected by several sets of joints, trending mainly east–west to northwest–southeast (Farag and Ismail, 1959; Moustafa et al., 1985).

Surface electromagnetic induction and electric techniques are nowadays widely used to image the bedrock geologic sequence and its effectual subsurface structures, without disturbing the ground surface, where such a bedrock geology is not accurately known or where ground logistics may restrict the direct drilling (Griffiths and Barker, 1993;