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Review article

Liquefaction potential of Nile delta, Egypt

Elsayed Fergany *, Khaled Omar

National Research Institute of Astronomy & Geophysics, Helwan, Cairo, Egypt

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ABSTRACT

Understanding how sedimentary basins respond to seismic-wave energy generated by earthquake events is a significant concern for seismic-hazard estimation and risk analysis. The main goal of this study is assessing the vulnerability index, K_g, as an indicator for liquefaction potential sites in the Nile delta basin based on the microtremor measurements. Horizontal to Vertical spectral ratio analyses (HVSR) of ambient noise data, which was conducted in 2006 at 120 sites covering the Nile delta from south to north were reprocessed using Geopsy software. HVSR factors of amplification, A, and fundamental frequency, F, were calculated and K_g was estimated for each measurement. The K_g value varies widely from south toward north delta and the potential liquefaction places were estimated. The higher vulnerability indices are associated with sites located in southern part of the Nile delta and close to the branches of Nile River. The HVSR factors were correlated with geologic setting of the Nile delta and show good correlations with the sediment thickness and subsurface stratigraphic boundaries. However, we note that sites located in areas that have greatest percentage of sand also yielded relatively high K_g values with respect to sites in areas where clay is abundant. We concluded that any earthquake with ground acceleration more than 50 gal at hard rock can cause a perceived deformation of sandy sediments and liquefaction can take place in the weak zones of $K_g \geq 20$. The worst potential liquefaction zones ($K_g > 30$) are frequently joined to the Damietta and Rosetta Nile River branches and south Delta where relatively coarser sand exists. The HVSR technique is a very sensitive tool for lithological stratigraphy variations in two dimensions and varying liquefaction susceptibility.

Contents

1. Introduction

Damages caused by the recent earthquakes are concluded as a direct result of local geological conditions affecting the ground motion (Nakamura, 2000). This effect is controlled by a variety of factors, including proximity to source, rupture characteristics and directivity, acoustic impedance contrasts, near-surface soil properties, and basin structural configuration. Best approach for under-

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* Corresponding author.
E-mail addresses: elsayed_fergany@hotmail.com (E. Fergany), khaledyosif2002@yahoo.com (K. Omar).

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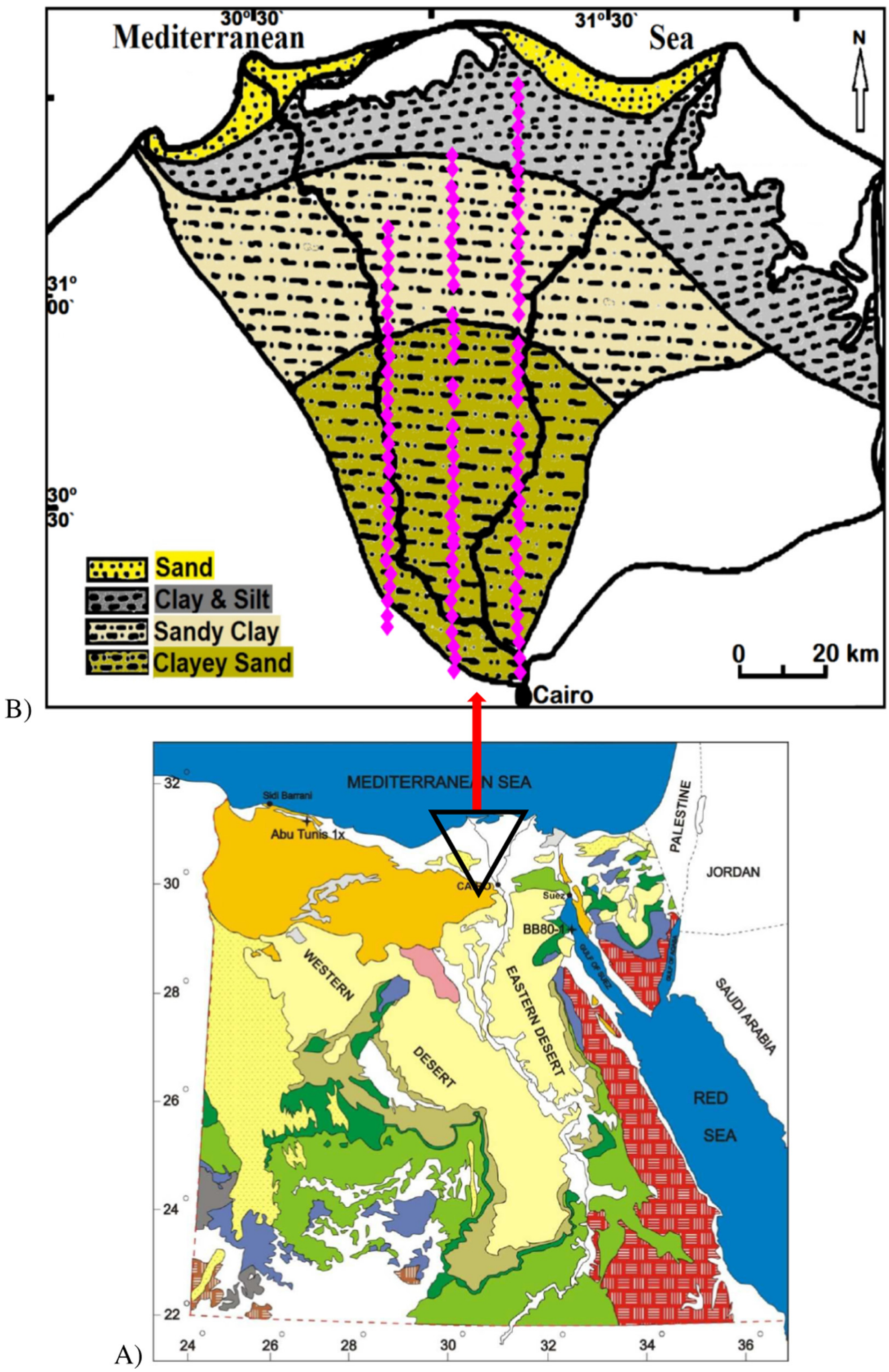

Fig. 1. (A) Egypt map shows study area (black triangle). (B) Study area map shows the distinct lateral variation in the Bilqas formation in the Nile delta (El-Fayoumi, 1987) and three longitudinal lines show microtremor measurements (diamond purple points) used in this study.

standing ground conditions is through direct observation of seismic ground motion, but such studies are restricted to areas with relatively high rates of seismicity. Because of these restrictions in other methods, such as high rates of seismicity and the availability of an adequate reference site, several studies suggest that ambient noise, or weak motions, can be used to identify areas that might amplify earthquake ground motions in advance of earthquake occurrence (e.g., Nakamura, 1989, 1997). After an introduction of