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Active tectonic structures in northeastern Egypt: a geospatial analysis using structural, remote sensing, and seismic data

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Abstract

The seismotectonic activity in Northeastern Egypt is intimately related to the active tectonic structures (mainly faults) which deform the region and induce intraplate seismicity. The present contribution is a new attempt to integrate structural, remote sensing, and seismic data, and implement a reliable geospatial analysis to investigate and assess the nature of the relation between tectonic structures and seismotectonic activity in the Cairo–Suez district which is an active seismic source zone in Northeastern Egypt. The achieved remote sensing and GIS-based geospatial analysis introduces valuable information on the frequency, orientation, and density of investigated tectonic fault trends. The spatial distribution of earthquakes epicenters which recorded during the period (1997–2016) with magnitude ($M_L \geq 3.0$) is evidently interrelated with the detected tectonic trends, and normal faulting with subordinate shear component is the most focal mechanisms indicated from the analyzed seismic events. The depth analysis of the studied earthquakes suggests a "hard linkage" between the major rift-boundary faults in the northern Gulf of Suez rift and the tectonic trends in the southern domain of the Cairo–Suez district, and thus indicates seismic activity on relatively deeper crustal levels. Most of the studied earthquakes have occurred on the WNW–ESE to NW–SE oriented faults in predominantly extensional to transtensional stress regime, which indicating the WNW to NW tectonic trend as an active fault trend. The intraplate seismotectonic activity in Northeastern Egypt is highly controlled by two active tectonic boundaries, the Red Sea–Gulf of Suez rift and Aqaba–Dead Sea transform (to the east) and the Pelusium Shear System (PSS, to the west). Any reliable hypothetical model explaining the seismotectonic setting in such region would consider the Cairo–Suez district as a large transfer zone transmitting the "far-field" stresses northwestward to the PSS with an effective mechanism keeping the within-plate WNW–ESE, NW–SE, and E–W tectonic trends highly prone to rejuvenation and seismic rupture.

Keywords Northeastern Egypt; · Active tectonic structures; · Remote sensing data; · Seismic data

Introduction

Northeastern Egypt has been widely known by historical earthquake activity registered during the last few centuries or more (2200 BC–1900 AD) (Fig. 1), and studied by several researchers (e.g., Poirier and Taher 1980; Maamoun et al. 1984; Ambraseys et al. 1994; Riad et al. 2004). Recent destructive earthquakes were also recorded along the same region (Hussein and Farouk 2000; Abdel-Rahman et al. 2003; Abou Elenean and Hussein 2008; Toni et al. 2016). Such data indicated that the occurrence of large and destructive earthquakes have been frequent and still possible inside the region and also draw the attention to the fact that northeastern Egypt is seismically active with a moderate to high level of seismic risk. The plate tectonic activity between the African, Arabian, and Eurasian plates is the driving force controlling the seismicity of northeastern Egypt and the East Mediterranean region as a whole. In fact, the majority of earthquakes occurred at shallow depths and coincided with the major tectonic trends of the Gulf of Suez rift, Gulf of Aqaba–Dead Sea transform, Pelusium Shear System, and their connection with the Gulf of

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