Arab J Geosci (2017) 10:11
DOI 10.1007/s12517-016-2786-y

ARABGU2016

# A new tectonic model for Abu-Dabbab seismogenic zone (Eastern Desert, Egypt): evidence from field-structural, EMR and seismic data

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Received: 31 August 2016 / Accepted: 5 December 2016


**Abstract** Abu-Dabbab area is the most active seismic zone in the central Eastern Desert of Egypt, where seismic activities are daily recorded. The reported earthquakes are microearthquakes of local magnitudes (ML < 2.0). A spatial distribution of these microearthquakes shows that the earthquakes of the area follow an ENE–WSW trending pattern, which is nearly perpendicular to the Red Sea Rift. Focal mechanisms of different fault styles were recognized with dominant normal faulting (with a strike-slip component) events characterized by focal depths greater than 7 km and reverse ones of shallower focal depths. Several lines of evidence indicating that the brittle-ductile transition zone underlies the Abu-Dabbab area occurs at a relatively shallow depth (10–12 km) and it is acting as a low-angle normal shear zone (LANF). Field-structural, EMR and seismic data (this study) reveal that the maximum compressive stress (σ1) in the area is perturbed from the regional NW–SE direction to ENE–WSW orientation. This stress rotation is evidently akin to the reactivation of the crustal scale Najd Fault System (NFS), where such reactivation is attributed to the ongoing activity/opening of the Red Sea. Our tectonic model proposes that the continuous activity on the brittle-ductile transition zone including the LANF led to stress localization, which triggering a brittle deformation in the upper crustal-levels and associated shallow dipping thrusts. Such bimodal tectonic model suggests that the deep earthquakes are owing to the tectonic movement on the LANF (transtension), whereas the shallow earthquakes are related to a brittle deformation inside the fault blocks of the upper crust (transpression). Deformation creep along this zone didn't permit continuous accumulation of strain and hence reduce the possible occurrence of large earthquakes.

**Keywords** Abu-Dabbab area · Seismotectonics · EMR-data · Tectonic model

This article is part of the Topical Collection on *Current Advances in Geology of North Africa*

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## Introduction

Abu-Dabbab area is located in the central Eastern Desert of Egypt, some 30 km north of Marsa Alam city on the Red Sea coast (Fig. 1). Three main wadis (valleys) are draining Abu-Dabbab area; Wadi Mubarak, Wadi Abu-Dabbab, and Wadi Dabr. The Abu-Dabbab area is one of the seismic source zones in Egypt, characterized by cannon earthquakes, long seismic activity, and earthquake swarms. The seismicity and unique geologic setting of the area have attracted the attention of many workers (e.g. Fairhead and Girdler 1970; Daggett et al. 1980 and 1986; Hassoup 1987; Kebeasy 1990; El-Hady 1993; Ibrahim and Yokoyama 1998; Badawy et al. 2008; Hosny et al. 2009 and 2012; Azza et al. 2012; Mohamed et al. 2013; Basheer et al. 2015; El Khrepy et al. 2015). The area has been subjected to two significant earthquakes on 12 November 1955 and 2 July 1984 with magnitudes 5.6 and 5.2, respectively (Fairhead and Girdler 1970; Badawy et al. 2008). The recorded seismic activity from Abu-Dabbab region by the Egyptian National Seismic Network (ENSN) ranges from 10 to 15 events/day to greater than 60 events/day during swarms (Badawy et al. 2008; Mohamed et al. 2013). Many earthquake swarms (1976, 1984, and 1993) were instrumentally recorded and discussed by several authors (e.g. Hamada 1968; Fairhead and Girdler 1970; Dagget

Published online: 29 December 2016