Structural Modeling and Tectonic Synthesis of the Northwestern Margin of Red Sea Rift, Egypt

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ABSTRACT

The present study concerned with tectonic evolution and structural synthesis of the NW margin of the Red Sea. The Red Sea represents the NW arm of the Red Sea, the Gulf of Aden and the East African triple Junction.

The stratigraphic succession of the studied area ranges in age from Precambrian to Recent with several breaks and hiatus and could be subdivided into two mega-sequences; the Pre-rift Precambrian-Eocene succession and the Syn-rift Oligocene-Quaternary succession. Integration of the data obtained from surface outcrops and subsurface investigations delineates the evolution of this sedimentary cover under the influence of tectonic regimes through geologic history. The Precambrian basement rocks are represented by eight Neoproterozoic rock units; Metavolcanics, Metasediments, Metagabbro-diorite, Older granites, Dokhan volcanics, Hammamat molasse-type sediments, Younger granites and Post Hammamat felsite. The Upper Cretaceous deposits are unconformably overlying the Precambrian basement rocks and developed along NW-oriented basins related to the late Cretaceous (Turonian) rifting phase. The marine incursion of the studied area led to deposition of the Upper Cretaceous-Eocene marine-dominated facies. The Middle to Upper Eocene deposits are missed in the studied area due to falling of the sea level. The oldest exposed syn-rift deposits are represented by the Oligocene continental facies and their associated basaltic extrusions referring to the initial stages of the Red Sea rifting. Miocene Facies and their distribution relative to the rift-related fault system reflect the successive phases of the Red Sea fault block evolution. The Pliocene deposits are continental to shallow marine deposits; reflecting isolation of the Red Sea from the Tethyan Ocean and connection with the Indian Ocean through the Strait of Bab El Mandab based on faunal assemblage. The Quaternary deposits reflect the Red Sea drifting and uplifting of hinterland mountains.

Lithologic differentiation of these rock units being encountered in the studied area is accomplished utilizing different remote sensing imagery enhancement techniques of the OLI data (Landsat-8) aided with field verification. Spectral signature analysis of different rock units, false-colour composite, band-ratio, principle component analysis, minimum

noise fraction, and independent component analysis are powerful tools in discrimination of the main rock units

Detailed mapping of the studied area shows NW-oriented structural provinces as, G. Hamadat, G. El-Anz, G. El-Duwi and G. Nakheil and W. Queih, with subordinate NE-oriented structural provinces e.g. G. El-Atshan and G. Rewagen.

The main structural elements recorded in the studied area are represented by NW to WNW- and NE- trending normal faults showing soft-linked (relay ramp and breached relay ramp geometry) and hard-linked geometries. WNW-striking convergent overlapping conjugate transfer zone (Duwi accommodation zone) between the NE-dipping faults of the northern structural domain overlaps and the SW-dipping faults of the southern structural domain. Kilometer-scale longitudinal plunged and double plunged syncline folds are developed at the hangingwall of these faults and recorded as drag folds (forced folds). E-W, N-S, NNE, ENE, and NE-oriented plunging and double plunging anticline and syncline folds are recorded in the study area as transverse folds either at the (orthogonal or oblique) fault-linked segments or isolated faults.

Analysis of the structural assemblages in the study area delineates their development in terms of successive phases of rifting. Tectonic evolution of the studied area in terms of structural analysis passed through the five main successive and intermittent deformational phases of different paleostress regimes as follows: 1) Mesozoic (Late Cretaceous, Turonian) rifting phase, **proposed for the first time in the present work**. 2) Phase Two: Late Eocene compressional phase. 3) Phase Three: Oligocene Rift Initiation phase. 4) Phase Four: Miocene Rifting phase. 5) Phase Five: Pliocene-Quaternary Rifting phase.