

The tectono-metamorphic evolution of the central part of the Neoproterozoic Allaqi–Heiani suture, south Eastern Desert of Egypt

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Abstract

The Precambrian basement of the Um El Tuyor area represents the central part of the *ca.* 750–720 Ma Allaqi–Heiani suture in the extreme south of the Egyptian Eastern Desert. It is composed of allochthonous ophiolitic thrust slices and detached sheets, island arc metavolcanic–volcanoclastic and metasedimentary assemblages, and syn- to post-orogenic granitoid intrusions. These rocks are collectively referred to as a fold-and-thrust belt in view of their deformational styles, and as ophiolites and their lithologic association are concerned. Structural analysis reveals three major deformation events, namely: (a) D1: an early thrust-and-fold system, through which overturned to recumbent folds and major thrusts were developed and later overprinted by a sinistral transpression, (b) D2: a NE–SW-compressional regime that deformed the D1 structures by major folds (F_2) and penetrative axial planar NW–SE foliations (S_2) and associated major NW–SE sinistral faults and shear zone, and (c) D3: a late ENE–WSW compressional strain increment expressed by a series of NNW–SSE striking folds and crenulations (F_3). Related right-lateral NNW–SSE strike slip faults and discrete brittle–ductile shear zones indicate a later transcurrent shear which is best developed in the metasedimentary successions.

Mineral associations and porphyroblast-matrix fabrics in the pelitic metasediments indicate three phases of regional metamorphism ($M_1 \rightarrow M_3$), syn-kinematic with D1, D2 and D3 respectively. Based on the petrographic and microprobe data, the peak metamorphic conditions were attained at 534°–561 °C/5.26–6.20 kbar, under which garnet, staurolite and sillimanite coexisted during D2. Although associated with the most significant metamorphic event, D2 corresponds roughly to a late collisional stage (650–620 Ma) during which the accreted Pan-African terrains attached to the East Saharan Craton. This is further confirmed by the D2-related sinistral strike slip faults that affiliate to the *ca.* 630–540 Ma Najd strike slip fault system in the Arabian–Nubian Shield.

Criteria including an anticipated fold–thrust vergence generally to northwesterly directions, discrete mesoscopic duplexes, shear bands, and minor folds and thrust zones all indicate that the ophiolites were emplaced roughly from northwest to southeast. However, deformation of the ophiolite basal contacts and associated fabrics argue that the northwestward rooting of the ophiolitic massif in the study area cannot be considered as a criterion for the original direction of tectonic transport, which was likely from north to south if the entire Allaqi–Heiani belt is considered. Such deviation is best attributed to rotation through deformation by the N–S Hamisana shear zone. This principally agrees with the tectonic evolution of the Arabian–Nubian Shield in south Egypt proposed previously, which includes an early N–S arc–arc collision followed by a stage of E–W crustal shortening.

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1. Introduction

Proponents of an arc accretion evolutionary model for the Arabian–Nubian Shield (ANS) regard the ophiolites as rem-

nants of oceanic crust obducted along destructive plate boundaries during the closure of small ocean basins, thus delineating sutures or fossil subduction zones (Bakor et al., 1976; Neary et al., 1976; Gass, 1977; Kröner, 1985; Shackleton, 1988; El-Gaby and Greiling, 1988). Stoeser and Camp (1985) compiled a tentative map of these boundaries and their associated orogenic zones for the Arabian Peninsula, and Vail (1985) extended this map to cover the entire ANS.

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According to Almond et al. (1989), the Neoproterozoic ANS was characterized by high strain zones which accommodated intensive ductile shearing. Some of these zones are reworked accretionary complexes and sutures, whereas others cut across the accreted microplates that compose the shield. They are mainly fold-and-thrust belts, characterized by the presence of allochthonous ophiolitic slices and sheets (Greiling et al., 1988). According to Abdelsalam et al. (2003), sutures of the ANS are divided into: a) arc–arc sutures (separating arc terranes) formed between 800 and 700 Ma, and b) arc–continent sutures (separating the ANS from East and West Gondwana) formed between 700 and 650 Ma (Stoeser and Camp, 1985; Pallister et al., 1989; Ayalew et al., 1990; Kröner

et al., 1992; Abdelsalam and Stern, 1996). The Allaqi–Heiani suture (Fig. 1) is an important structure in the northern ANS, belonging to the first category, formed when the *ca.* 750 Ma Gerf terrane in the north overrode the $\sim$ 830–720 Ma Gabgaba terrane in the south, prior to closure of the Mozambique Ocean (Abdelsalam and Stern, 1996; Abdelsalam et al., 2003). It is associated with the large Allaqi–Heiani, Gerf and Onib–Sol Hamed ophiolites in SE Egypt and NE Sudan (Kröner et al., 1987; Stern et al., 1989; Zimmer et al., 1995; Abdelsalam and Stern, 1996). These ophiolites range in age between $\sim$ 800 and 730 Ma (Pallister et al., 1989; Kröner et al., 1992). Formation of this structure embraces the evolution of the ANS from oceanic lithosphere to island-arc and continental lithosphere

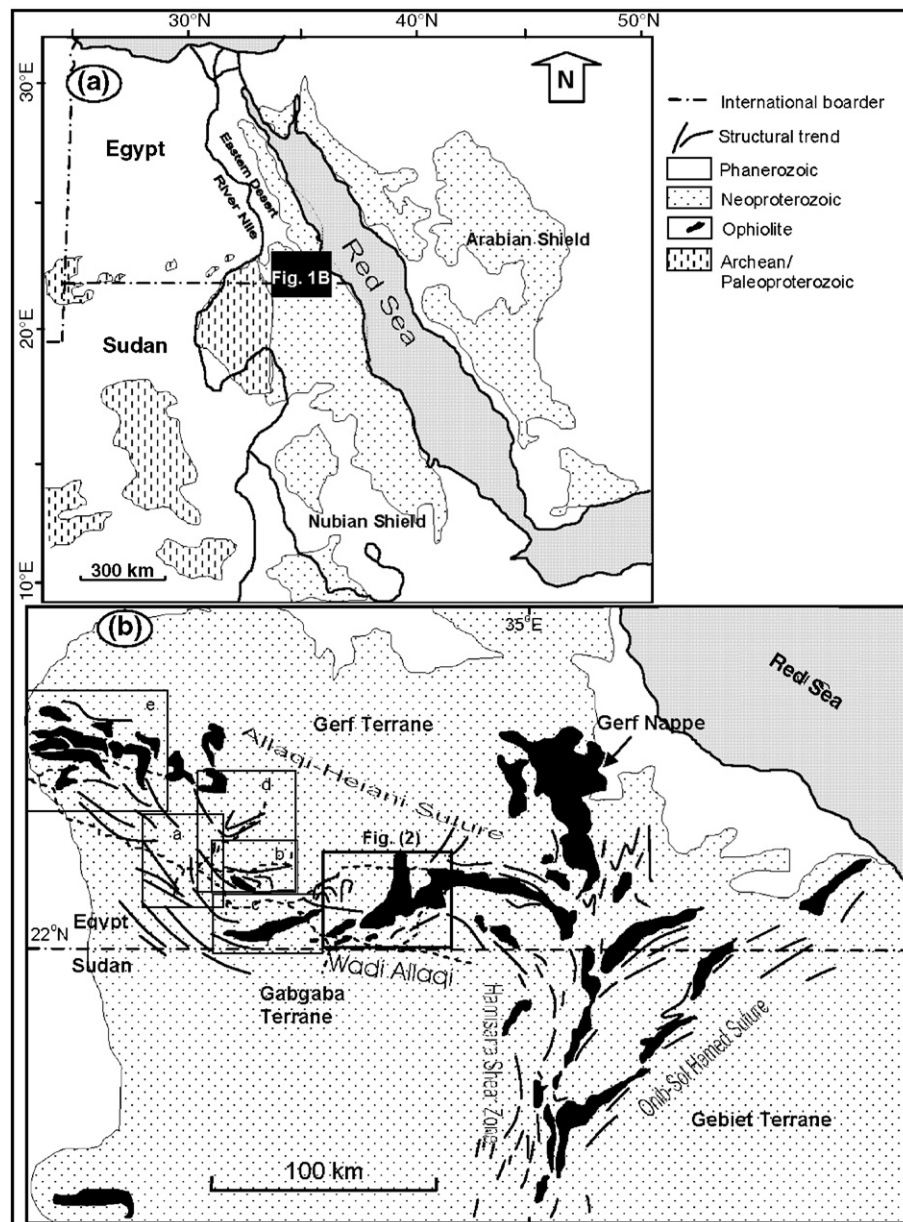


Fig. 1. a) Distribution of the Archean–Paleoproterozoic and Neoproterozoic rocks in north-east Africa, b) Tectonic sketch map of the Allaqi–Heiani suture and the northern part of the Hamisana Shear Zone (modified after Stern, 1994; Abdelsalam et al., 2003 and references therein). Previously studied parts of the Allaqi Heiani Suture are shown as boxes with labels: (a) Taylor et al. (1993), El-Kazzaz and Taylor (2001), (b) Sadek (1994); (c) Abdel-Maguid et al. (1996), (d) Greiling et al. (1994), (e) Kusky and Ramadan (2002), Abdelsalam et al. (2003).

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