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Early Cretaceous counterclockwise rotation of Northeast Africa within the equatorial zone: Paleomagnetic study on Mansouri ring complex, Southeastern Desert, Egypt

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Abstract The Mansouri ring complex (132 Ma) is, paleomagnetically, studied to shed light on the paleo-tectonic position of Northeast Africa during the Early Cretaceous. Progressive thermal demagnetization of all samples verified a general bi-vectorial decay of the natural remanence. After the removal of the present-day field overprint, the decaying anchored component was either:

1. A dual-polarity, shallow NW–SE directed component residing in magnetite (400–585 °C) of shiny fresh samples, or,
2. A normal-polarity, medium-inclination, north-oriented component stored in haematite of few reddish ferruginous sites. This component was considered as chemical remagnetization carried by secondary haematite.

Due to its steady stability, overwhelming existence in most sites, positive reversal test and its residence in fresh-samples' magnetite, the first dual-polarity, shallow NW–SE component, was considered as the characteristic remanent magnetization [ChRM] representing the paleomagnetic field during cooling of the Mansouri ring complex. The mean paleomagnetic pole of the isolated ChRM was at 47°N/259°E, Dp/Dm = 3.4°/6.6°.

This Hauterivian pole from Egypt shows reasonable consistency with its coeval poles rotated from the main tectonic units to Northeast Africa. It reveals that in Early Cretaceous:

1. Northeast Africa was equatorial, lying just south the Equator. Cairo, which is now at 30°N, was at −1.5° paleo-latitude.

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2. The Azimuth of the African Plate was NE–SW, about 30° clockwise with respect to the present-day N–S trend.

Comparing this Hauterivian pole to that of the Wadi Natash basalts [107 ± 4 Ma], which was at [55°N/250°E] during the Albian, the African Plate seems to have rotated counter-clockwise about 10° with Northeast Africa moving northwards [Cairo was moving from 1.5°S to 1.5°N] within the equatorial zone, during the Early Cretaceous.

1. Introduction

In the Early Cretaceous, West Gondwana was suffering progressive fragmentation by the northward propagation of the South Atlantic rift between Africa and South America. During the Barremian, sea-floor spreading of the South Atlantic began from the south, concurrently, associated with reorganization of the Central Atlantic Ridge (Klitgord and Schouten, 1986; Savostin et al., 1986). Despite that the lithospheric extension was, certainly, underway in the Valanginian, the sea-floor spreading initiation was not earlier than 133 Ma ago (Rabinowitz and Labrecque, 1979), or slightly later between 130 and 125 Ma ago (Milner et al., 1995).

During its northward propagation, the South Atlantic created a North–South-oriented stress field in West and central Africa, reactivating the East–West-trending, Pan-African-aged, Central African Shear zone (Daly et al., 1989; Maurin and Guiraud, 1993). On top of the Central African shear zone, the African Plate was, deeply, fragmented by two rift systems: the equatorial East–West-trending Central African rift and the West African rift. These intra-plate rifts created impressive intra-plate deformations within Africa and plate rearrangement extending as far as the Indian Ocean (Wilson and Guiraud, 1992). The associated ocean-continent interaction provided concurrent widespread intra-plate extensional stresses evolving a system of East–West trending rifts interconnected by NW–SE trending strike-slip faults (Guiraud and Maurin, 1991, 1992), along which numerous, moderately, subsiding sedimentary basins with horst and graben structures evolved (Janssen et al., 1995) many of them are petroliferous.

Despite that the Valanginian drop in sea-level led to a general regression and scarcity of the Early Cretaceous sedimentary rocks, the associated intra-plate rifting within Africa created a phase of regional volcanic activity in Northeast Africa. This Early Cretaceous regional magmatic activity is marked in the Southeastern Desert of Egypt by the presence of frequent alkaline ring complexes (El-Reedy, 1979; Hashad and El-Reedy, 1979; Serencsits et al., 1979, 1981; Meneisy, 1990) in the northeastern Red Sea hills in Sudan (Klemenic, 1987; Semtner, 1993) and Israel (Lang et al., 1988; Lang and Steinitz, 1989; Garfunkel, 1992).

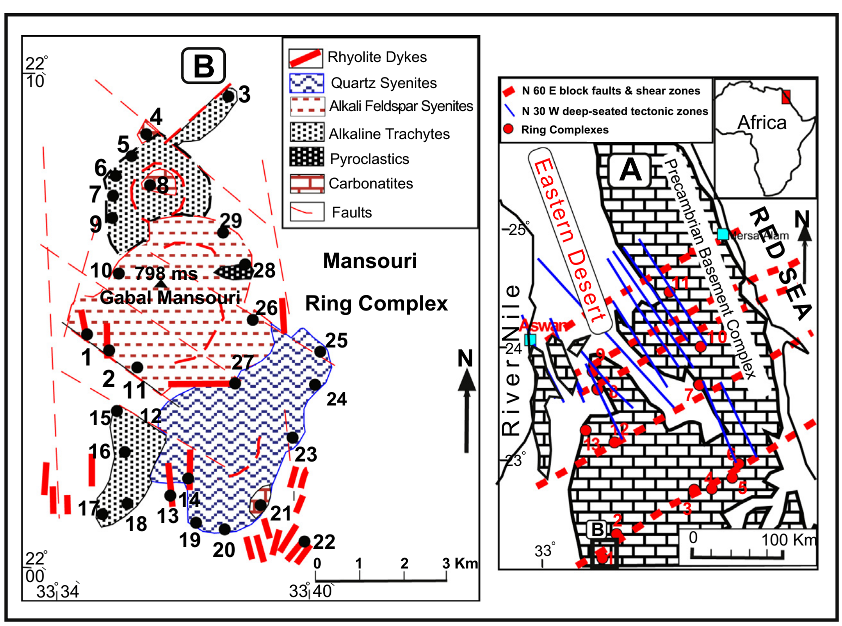

Fig. 1 (A) Distribution of the ring complexes in the Southeastern Desert of Egypt along the main tectonic fractures of the Precambrian basement complex (modified after Garson and Krs, 1976). Numbers denote the ring complexes: 1 – Mansouri, 2 – Gezira, 3 – Naga, 4 – Mishbeh, 5 – Nigrub El-Fogani, 6 – Nigrub El-Tahtani, 7 – Zargat Naam, 8 – Tarbtie South, 9 – Tarbtie North, 10 – Kahfa, 11 – Abu Kruq, 12 – Hadayib, and 13 – Um Risha. (B) Simplified geologic map of Mansouri ring complex (El-Nisr and Saleh, 2001) showing the main rock units along with the numbers and location of the sampling sites.