



Research paper

Structural regime and its impact on the mechanism and migration pathways of hydrocarbon seepage in the southern Gulf of Suez rift: An approach for finding new unexplored fault blocks



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ABSTRACT

A Natural active oil seepage occurs at the intersection of the NW-oriented rift coastal fault and a NE-oriented cross fault which bound the southwest dipping Little Zeit tilted fault block at the southwestern side of the Gulf of Suez, Egypt. Detailed surface geological mapping followed by subsurface mapping using aeromagnetic, seismic and borehole data of Ras El Ush oilfield (the nearest oil field to the seepage) provide a reliable hydrocarbon migration pathway model of the area.

The proposed model suggests that hydrocarbons migrated upward at the intersection of a NE-oriented and the NW-oriented rift coastal faults where they found their way to the surface. The Nubia Sandstone occurs south of Ras El Ush oilfield in a trap door structure and probably entrapped some of the migrating hydrocarbons while a probable oil-water-contact at –1000 m which resulted into the migration of hydrocarbon through the damage zone of the northeast fault.

The original oil in place of the predicted reservoir is estimated to be more than 47.5 MMBO which encourages the design makers for more investigation of this reservoir to increase its certainty and putting it in the plan of the future investments.

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1. Introduction

Natural hydrocarbon seepage was the incentive for exploration drilling by the pioneers of the petroleum industry as long ago as the 1860s in Pennsylvania and Azerbaijan (Williams and Lawrence, 2002). Seepage has also given some of the first indications of the presence of petroleum in most of the world's petroleum producing regions, with at least half the reserves proved by 1952 discovered by drilling on or near seeps (Judd and Hovland, 2007). Hydrocarbon seepage can, in selected geological settings, also delineate subsurface petroleum accumulations and provide information on hydrocarbon charge type or oil quality. Therefore, the study of natural hydrocarbon seepage has proven to be a valuable aspect in petroleum prospectivity assessment and exploration.

Since the beginning of the last century, the Gulf of Suez has been a highly prospective hydrocarbon location and the focus of much oil exploration. The Gulf of Suez is an intercontinental rift consisting of

an elongated graben about 300 km long and 30 km wide between the Sinai Peninsula and the Eastern Desert of Egypt (Fig. 1). Various recognized source rocks deposited in distinct, well-defined environments exist within the Gulf of Suez basin, and several models for oil generation and oil/source correlations have been proposed (Rohrback, 1982; Shahin, 1988; Mostafa, 1993; Robison, 1995; Barakat et al., 1997).

Gebel El Zeit is located on the southernmost western shore of the Gulf of Suez (Fig. 1). At the southern end of Gebel El-Zeit, a natural active seepage zone of oil occurs on the land surface in an area underlain by asphalt-saturated post-Miocene fractured limestone and coral reefs. Near the seep there are two ancient hand-dug wells. According to Harrell and Lewan (2002), pottery littering the ground around these wells dates from the late Imperial Roman Period (1st – 6th centuries A.D.) and the Islamic Period (11th – 16th centuries A.D.), but also present are a few pottery shreds from the Middle Kingdom or second Intermediate Period (16th – 20th centuries B.C.). The presence of liquid petroleum, through which gas bubbles continually rise, indicates that the seepage is still active (Fig. 2).

This paper provides an integrated geological and geophysical

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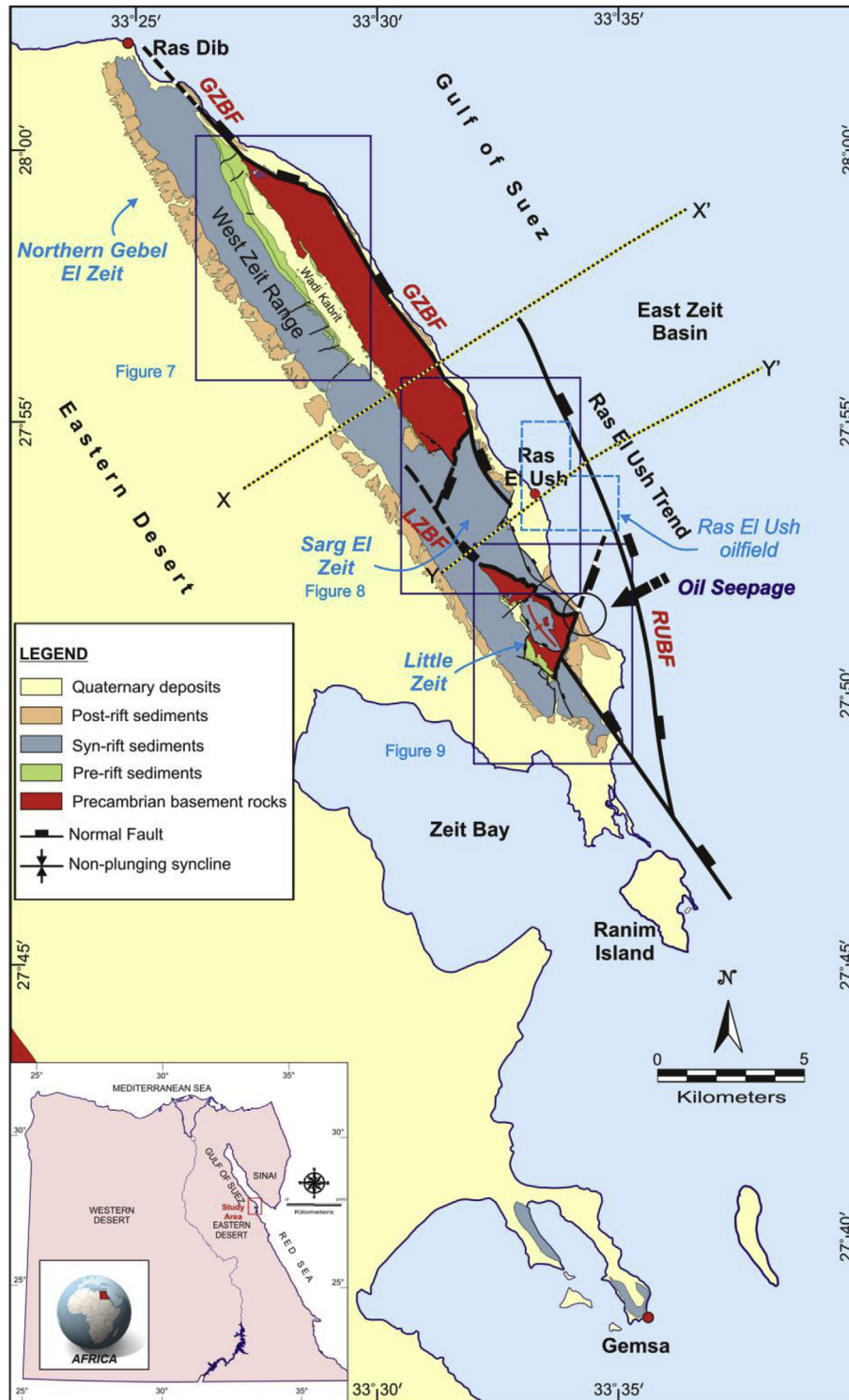


Fig. 1. Simplified geological map of Gebel El Zeit area and the location of oil seepage.

study to afford a reasonable origin of the onshore active oil seepage of Gebel El Zeit area.

2. Stratigraphic setting

The Gulf of Suez stratigraphy has been discussed by many workers. According to Said (1962, 1990), the stratigraphic

succession of the Gulf of Suez province is generally characterized by 3 main depositional sequences relative to the Miocene rifting events, as: pre-rift sequence (including the Precambrian basement rocks and a sedimentary succession up to the Eocene); syn-rift sequences (Early-Middle Miocene successions) and post-rift sequence (Late Miocene to Recent successions). The first and second sequences include important hydrocarbon source and

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