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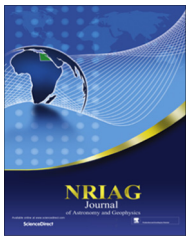

Geothermal studies in oilfield districts of Eastern Margin of the Gulf of Suez, Egypt

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Abstract Results of geothermal studies carried out at 149 onshore oil wells have been used in evaluation of temperature gradient and heat flow values of the eastern shore of the Gulf of Suez. The investigations included temperature logs in boreholes, calculation of amplitude temperature, geothermal gradients and heat flow. The results obtained indicate that geothermal gradient values are in the ranges of 0.02–0.044 °C/m and regionally averaged mean heat flow values are found to fall in the interval of 45–120 mW/m^2. Temperature gradients and heat flow values change from low values eastward to high values toward the axial of Gulf of Suez rift. The result of this research work has been highly successful in identifying new geothermal resources eastward of the Gulf of Suez. Additionally, this study shows that the areas with relatively higher temperature gradients have lower oil window, mature earlier, than those with low gradient values. Thus, high temperature gradients cause to expedite the formation of oil at relatively shallow depths and narrow oil windows. On the other hand, low temperature gradient makes the oil window to be quite broad when locate at high depths.

1. Introduction

Unlike most of countries, there is no sufficient information on the thermal status of Egypt. However, the tectonic position of Egypt in the northeastern corner of the African continent suggests that it may possess significant geothermal resources, especially along its eastern margin (Morgan et al., 1985). Egypt is bounded to the east by what has been interpreted as spreading center in the Red Sea and Gulf of Suez (McKenzie et al., 1970) and indicates that the potential for development

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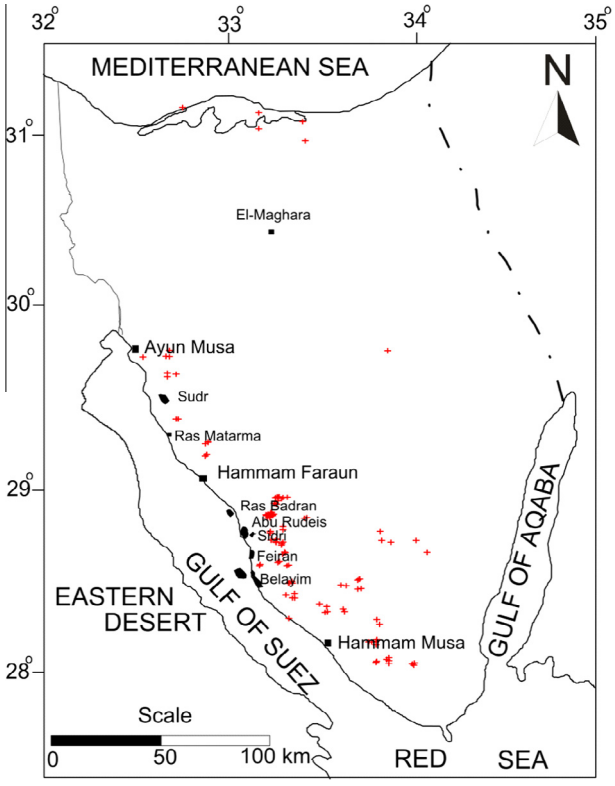

Fig. 1 Location map of the Gulf of Suez region, showing the locations of the hot springs on the eastern margin of the Gulf. Locations of the oil wells used in the geothermal studies are plotted as red crosses.

of geothermal resources is located along the Red Sea and Gulf of Suez coasts. Consequently, the Gulf of Suez region is one of the most interesting geothermal areas in Egypt because of its spring's high temperatures. The hot springs at the eastern coast of the Gulf of Suez include Ayun Musa (37 °C), Ain Hammam Faraun (70 °C) and Hammam Musa (48 °C) (Sturchio et al., 1996). These springs are probably of tectonic or non-volcanic origin associated with the opening of the Red Sea–Gulf of Suez rifts (Boulos, 1990). Geothermal studies were carried out at the eastern margin of the Gulf of Suez, where the distributed bottom-hole temperature records of deep offshore and onshore oil wells are shown (Fig. 1). The main objective of this study is to evaluate new localities for geothermal energy resources which are used for the development of the area. Based on these temperature logs data, the temperature gradients and heat flow characteristics of the eastern side of the Gulf of Suez were calculated. Geothermal parameters, including amplitude of temperature (A), mean surface temperature (MST), Geothermal gradient (GG), regression coefficient (R^2), thermal conductivity (K) and heat flow (Q), were calculated. Additionally, we studied the impact of the temperature gradients on the rate and extent of hydrocarbon maturation that consider the prime interest of valuation of oil fields.

Many geothermal explorations were conducted in Egypt using thermal gradient/heat flow and groundwater temperature/chemistry techniques as well as geophysical tools. Morgan and Swanberg (1979) showed high heat flow values, up to 175 mW m^{-2}, approximately three times the normal values, in the eastern Egypt, and the heat flow appears to increase toward the Red Sea coast. Also, Morgan et al. (1983) discovered a regional thermal high and a local thermal anomaly along the eastern margin of Egypt. El-Nouby (1990) studied

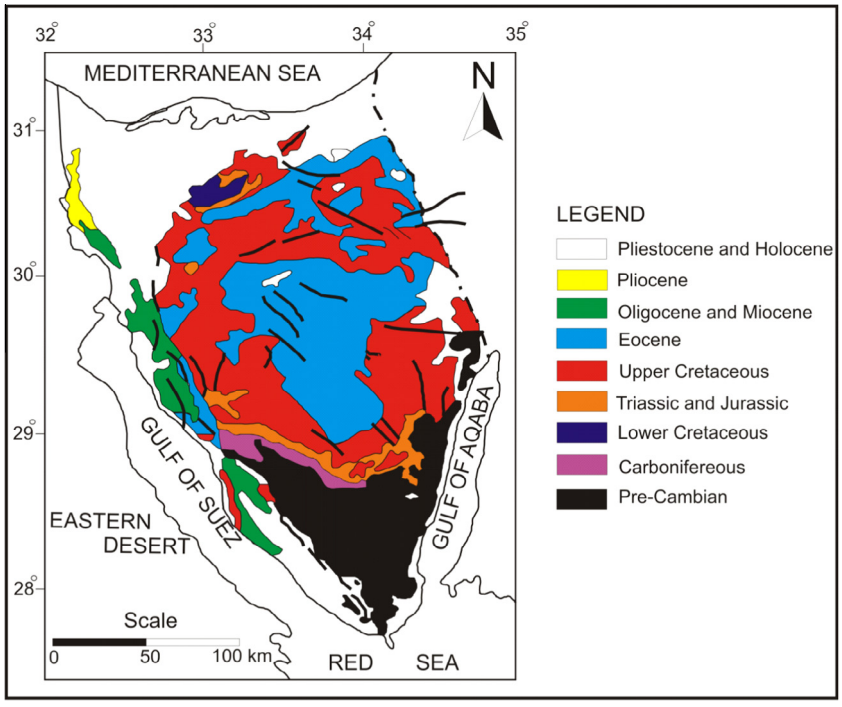

Fig. 2 Main surface geologic setting of Sinai Peninsula (Omara, 1972 and Kora, 1995). Heavy lines indicate the major faults in Sinai Peninsula.