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FULL LENGTH ARTICLE

Evaluation of the nature, origin and potentiality of the subsurface Middle Jurassic and Lower Cretaceous source rocks in Melleiha G-1x well, North Western Desert, Egypt

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Abstract The present work aims to evaluate the nature and origin of the source rock potentiality of subsurface Middle Jurassic and Lower Cretaceous source rocks in Melleiha G-1x well. This target was achieved throughout the evaluation of total organic carbon, rock Eval pyrolysis and vitrinite reflectance for fifteen cutting samples and three extract samples collected from Khatatba, Alam El Bueib and Kharita formations in the studied well. The result revealed that the main hydrocarbon of source rocks, for the Middle Jurassic (Khatatba Fm.) is mainly mature, and has good capability of producing oil and minor gas. Lower Cretaceous source rocks (Alam El Bueib Fm.) are mature, derived from mixed organic sources and have fair to good capability to generate gas and oil. Kharita Formation of immature source rocks originated from terrestrial origin and has poor to fair potential to produce gas. This indicates that Khatatba and Alam El Bueib formations take the direction of increasing maturity far away from the direction of biodegradation and can be considered as effective source potential in the Melleiha G-1x well.

1. Introduction

The Melleiha G-1x well is located in the northern province of the Western Desert basin (Fig. 1). The subsurface Jurassic and Cretaceous sediments in the North Western Desert Basin, including the studied well have attracted the attention of petroleum geologists, because of their wide areal distribution, huge thickness and their facies characteristics. These sediments have produced a commercial quantity of oil and gas, which lead many Egyptian and foreign exploration companies to concentrate their research in this area since 1970 [1].

The present study is an attempt to identify, and evaluate the nature and origin of the potentiality of subsurface Middle Jurassic and Lower Cretaceous source rocks in Melleiha G-1x well in order to identify the quantity and quality of hydrocarbon generation. They have the capability of hydrocarbon generation for oil and gas. Evaluation of the depositional environments for different organic facies and thermal maturation of the source rocks and organic matters was made. These

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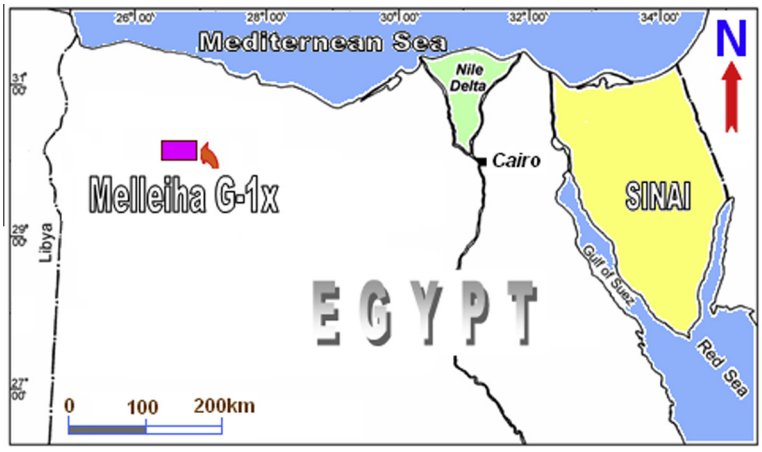

Figure 1 Location map of the studied well in the North Western Desert, Egypt.

targets have been achieved through geochemical analyses (pyrolysis) of ''15'' rock samples and three gas chromatography analyses for source rock extracts also done in this study.

The studied well lies in the unstable shelf between north–south oriented graben of the Mtruh basin and a very large graben of Shushan basin. These grabens are filled with very thick Jurassic and Lower Cretaceous sediments. It is dominated by NW–SW trending faults which were developed during Late Jurassic–Early Cretaceous and Late Cretaceous–Early Tertiary times [2]. The Melleiha lease is dominated by NW–SE trending small throw faults. This tectonic activity occurred mainly during Late Jurassic–Early Cretaceous times [3].

The sedimentary section of the North Western Desert including study area is shown in Fig. 2. The Middle Jurassic–Lower Cretaceous succession in the study area consists of the Middle Jurassic Khatatba Formation, composed of sandstones, shales, and some carbonates [1]; the Barremian-Early Aptian Alam El Bueib Formation, made up of shales, sandstones and some dolomites; and the Early Albian Kharita Formation is characterized by sandstones with minor intervals of shales.

The hydrocarbon potentiality of the Middle Jurassic and the Lower Cretaceous source rocks in the North Western Desert basin have been discussed by many authors. Sharaf et al. [4] mentioned that the Middle Jurassic (Khatatba Fm.) is an important source rock, while the Lower Cretaceous (Alam El Bueib Fm.) is an effective source rock for hydrocarbon accumulation in the south Matruh area. El Nady [5] revealed that the Alam El Bueib Formation of the Lower Cretaceous source rock is a good source for hydrocarbon generation in West Razzak–Alamein area. El Nady and Hammad [6] stated that the Lower Cretaceous (Kharita Fm.) might act as an important source for oil generation in Bade El Din Concession. Sharaf and El Nady [7] recognized that the oils from Alam El Bueib and Bahariya reservoirs are genetically related, multisourced from Khatatba and Alam El Bueib source rocks with minor contribution from Kohla source rocks. El Nady and Ghanem [8] showed that the Khatatba Formation entered the early stage of hydrocarbon generation during Late Cretaceous–Eocene. Alam El Bueib Formation during Late Cretaceous–Oligocene. Bahariya Formation is still immature and does not reach the onset of hydrocarbon generation. Younes [9] proved that, the shale rock of the Khatatba Formation in the Qarun field reached the late mature stage of oil generation. Ramadan et al. [10] recognized that the Alam El Bueib source rock in Tut oil field varies from poor to very good organic richness with kerogen of type III and is characterized by immature to mature rocks. El Nady [11] showed that Masajid Formation started to generate hydrocarbons during Late Cretaceous–Late Khatatba Formation during Late Cretaceous–Eocene and Ras Qattara Formation started to generate hydrocarbons during Paleocene. Tahoun et al. [12] recognized that the Alam El Bueib, Kharita and Bahariya formations in the Western Desert are comprised principally of type IV kerogen and a few type III kerogen components. El Nady [13] based on the results of biomarker analyses of source rocks of some wells in the North Western Desert, suggest that Lower Cretaceous Alam El Bueib source rocks are moderately mature and has organic matter deposited in deltaic environment with significant input of terrestrial, marine algae and bacterial contributions.

2. Materials and methods

Fifteen cutting samples of argillaceous siltstones and silty shales represented the Middle Jurassic rock unit (Khatatba Fm.), and the Lower Cretaceous rock unit (Alam El Bueib and Kharita fms.). These samples were taken at different depths from Melleiha G-1x. The location of the studied samples is shown in Fig. 3. The lithology of these samples is sandstones, shales, and some carbonates.

The samples were finely ground. Total organic carbon (TOC) was determined by carbon analyzer (TOC 2000) after the removal of carbonates by treatment with hydrochloric acid (10%). Rock–Eval pyrolysis was performed according to the procedure described by Espitalie et al. [14] to obtain *S*1, *S*2, *S*3 and Tmax data. Vitrinite reflectance (R_o%) measurements were made on thin sections under reflected light.

The saturated hydrocarbon fractions were analyzed by high resolution of GC. The analysis was performed on a Hewlett Packard 5890 series II instrument equipped with a split–splitless injector, a flame ionization detector and a fused silica capillary column (30 m × 0.25 mm). The GC oven was started at 60–160 °C, held isothermally for 2 min, and then programed to 300 °C at 10 °C/min and held isothermally for 10 min.