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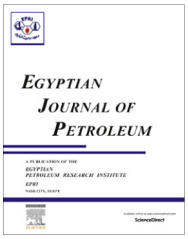

FULL LENGTH ARTICLE

Geochemical and biomarker characteristics of crude oils and source rock hydrocarbon extracts: An implication to their correlation, depositional environment and maturation in the Northern Western Desert, Egypt

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Abstract Oil–oil and oil–source rock correlations are used in this study in order to achieve their relationship, depositional environments and diagenetic processes in the source rocks. Three oil samples and source rock hydrocarbon extracts were analyzed using relative geochemical analyses, and gas chromatography–mass spectrometry are used for this purpose. The results revealed that the extracts of the Alam El Bueib and Khatatba formations are derived from mixed organic sources in which terrestrial dominates marine sources, and deposited in transitional environments under less anoxic conditions. The extracts of Bahariya formation are derived from mixed marine inputs with a limited terrestrial contribution. The Alam El Bueib oil shows more contribution of terrestrial than marine sources. Also, a genetic close relation between them supported the indigenous mixed source of Alam El Bueib oil which related to different sources including the Khatatba, Alam El Bueib and Bahariya formations. Accordingly, the Alam El Bueib formation can be considered as an important source for petroleum generation in the Northern Western Desert.

1. Introduction

Oil–oil and oil–source rock correlations are more difficult than oil–oil correlations. This is due to many problems in their sampling, analyses and/or interpretation of the available data. Such interpretations must be confirmed by different parame-

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ters such as gross composition of oil and source rock extracts, biomarker analyses. These parameters solve most of problems in oil–source correlations, because the differences in the chemical composition of the oil and the organic matters retained in the source rock are a function of migration fractionation and post-migration alteration [1]. The oil itself is affected greatly after reaching the final reservoir. Therefore, the bulk correlation parameters previously discussed in oil–oil correlation are not useful in oil–source correlation.

Geochemical studies on oils from the North Western Desert were carried out by many workers. Zein El Din et al. [2] recognized two oil families in the North Western Desert namely: Abu Gharadig and Umbarka groups of marine and terrestrial origin respectively. Mostafa et al. [3] recognized four oil types in the North Western Desert. Oils from Shushan and Matruh Basins are characterized by terrestrial wax input, while oils from Abu Gharadig Basin are generated from marine siliciclastic source rocks, and those from Alamein Basin are seemed to be derived from mixed marine/terrigenous sources. El Nady [4] divided the oil of some oilfields of the North Western Desert into two types: (1) waxy oil was from non-marine origin. (2) Non waxy oil was sourced from carbonates source rocks. Ghanem et al. [5] recognized two oil groups in the North Western Desert (light and heavy oil), which are rich in terrigenous organic matter. Sharaf and El Nady [6] recognized that the oils from the Alam El Bueib and Bahariya reservoirs are originated from the Khatatba and Alam El Bueib source rocks with a minor contribution of the Kohla source rocks. El Nady et al. [7] classified the crude oils of the Meleiha oil field into two classes namely, paraffinic and deltaic oils, originating from marine and terrigenous sources, respectively. El Nady [8] reported that the oils from the Khatatba and Alam El Bueib formations are mature, derived from source rocks containing marine and terrestrial organic matter, and similar to that of the Khatatba source rock extract. El Nady and Harb [9] revealed a genetic close relationship and remarkable similarities in the origin and maturation for the oils and extracts of the Khatatba and Alam El Bueib source rocks of some oilfields in the North Western Desert. El Nady [10] showed that there is a good correlation between the extracts of the Bahariya and Khatatba formations and crude oils from the Qarun and Misaada oilfields. El Nady [11] concluded that the crude oils of some wells in the Northern part of the Western Desert originated mainly from marine organic sources deposited in a reducing environment. The present study aims to do a correlation of geochemical and biomarker characters of oil–oil and source rock hydrocarbon extracts, and infer their depositional environments and maturation.

2. Materials

Three oil samples are collected from different wells scattered within the study area namely: Salam-3x, Yasser-1x, Tut-1x (Fig. 1). Three source rock hydrocarbon extract samples are collected from well Salam-3x, well Yasser-x and well Tut-1x to represent the Jurassic Khatatba formation and Cretaceous Bahariya and Alam El Bueib formations, respectively. For the biological marker correlations three source rock hydrocarbon extracts from the Khatatba, Alam El Bueib and Bahariya formations and oil sample from Alam El Bueib reservoir are recognized.

Figure 1 Location map studied wells in the Northern Western Desert, Egypt.

3. Methodology

(1) The crude oils and source rock extracts samples were separated into saturate, aromatics and resins by column chromatography. The column was packed with 1:1 (by weight) alumina overlying silica gel such that the weight of the sample (asphaltenes free) was about 2% of the combined weight of the packed materials. Successive elution with *n*-heptane, toluene and chloroform yielded saturates, aromatics and resins component fractions, respectively. The obtained fractions were made free from solvents by evaporation. The results are expressed as weight percent to the whole oils and extracts.

(2) Saturated hydrocarbon fractions were achieved by gas chromatographic analysis using the Perkin Elmer Instrument Model 8700, provided with a flame ionization detector (FID). The oven temperature was programmed for 100 to 320 °C at 3 °C/min and the final time 20 min. SPB-1 capillary column was of 60 m in length and 0.53 i. d. Nitrogen was used as a carrier gas, the optimum flow rate was 6 ml min. Gas chromatography–mass spectrometry used a 50 m × 0.25 mm fused silica capillary column of bonded SE 54 installed with a finnigan MAT TSQ-70 combined gas chromatography/quadrupole mass spectrometer. The column oven was programmed from 100 to 310 °C at 4 °C/min. These analyses were carried out in the laboratories of the Egyptian Petroleum Research Institute.

4. Results and discussions

4.1. Specific compounds

The saturate and aromatic hydrocarbons as well as, the asphaltenes and resins of the studied crude oil and source rock extracts are listed in Table 1. It is obvious that, all the oil samples are enriched with saturated hydrocarbon fractions as they represent more than ≈70% and more than 56% paraffins, less than 16% naphthenes of the crude oil samples (Table 1) indicating paraffinic high waxy oil type [12]. Moreover, the abundance of paraffins over naphthenes and NSO compounds suggests that, all the oils are mainly mature. On the other hand, the source rock extracts of the Bahariya, Alam El Bueib