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FULL LENGTH ARTICLE

Mineralogical, geochemical and hydrocarbon potential of subsurface Cretaceous shales, Northern Western Desert, Egypt

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Abstract Twenty four Cretaceous shale core samples of Gibb Afia-1, Betty-1, Salam-1X and Mersa Matruh-1 wells were mineralogically and geochemically studied using XRD, XRF and Rock Eval Pyrolysis. Kaolinite, smectite and illite are the main clay minerals in addition to rare chlorite, while the non-clay minerals include quartz, calcite, dolomite and rare siderite. The shales were derived through intensive chemical weathering of mafic basement and older sedimentary rocks. These sediments were deposited in a near-shore shallow marine environment with some terrestrial material input. The shales have poor to fair organic content. It is marginally to rarely mature.

1. Introduction

Cretaceous sediments cover a wide area of the surface of Egypt [1]. The subsurface of the Northern Western Desert comprises a number of structurally controlled sedimentary basins where several rock facies were deposited [2]. Exploration activities in the Northern Western Desert led to significant oil and gas discoveries in the Cretaceous rocks [3]. The hydrocarbon potentiality of the Lower Cretaceous source rocks in the North Western Desert basin have been discussed by many authors; [4] mentioned that the Lower Cretaceous (Alam El Bueib Fm.) is an effective source rock for hydrocarbon accumulation in the south Matruh area. [5] stated that the Lower Cretaceous might act as an important source for oil generation in Bade El Din Concession. [6] 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. [7] 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. It is interesting to get more information about the shale facies as one of the most important oil and gas source rocks. For this reason; the shale core samples from four wells namely Gibb Afia-1, Betty-1, Salam-1X and Mersa

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Matruh-1 (Fig. 1) were mineralogically and geochemically studied to define their characteristics, condition of deposition and hydrocarbon potentiality.

2. Sampling and methodology

Twenty five shale samples were selected from the four wells for the present study. Distribution of these samples is illustrated in (Fig. 2). Thirteen samples were analyzed by XRD by using the oriented method to define their clay minerals, and four samples of them were analyzed by the bulk method.

About 20 g of each sample for the oriented method is granulated, treated with HCl (3%) to dissolve carbonate, H_2O_2 and carefully washed several times with distilled water, then sieved using 0.063 mm sieve, shacked and dispersed in one-liter cylinder. Three oriented slides were prepared for each sample by sedimentation of clay fraction drawn off at a depth of 10 cm. from the suspension surface on clean glass slides after 24 h [8,9]. The first slide was used as untreated specimen, the second was saturated with ethylene glycol and the third was heated at 550 °C for two hours and slowly cooled. The analyses were carried out at the laboratories of Egyptian Petroleum Research Institute (EPRI) using a Phillips apparatus model X' Pert PRO, PANalytical, Netherland. Twenty two samples were geochemically analyzed by XRF for their major and trace elements. The analyses were carried out at the Egyptian Applied Research Laboratories, CMRDI using a Phillips PW 1404 WD-XRF via program "POWDER". Fourteen samples were analyzed using Rock Eval 6 analyzer at the laboratories of EPRI to study their organic contents and hydrocarbon potential.

3. Stratigraphy

The Cretaceous rocks in the studied area are divided into Lower Cretaceous and Upper Cretaceous units [10] as shown in (Fig. 3). The following is a brief description of these units from top to bottom:

3.1. Khoman formation (Santonian–Maestrichtian)

It consists mainly of fractured chalk, filled with calcite crystals. Ali et al. [11] reported that, the lower part of the Khoman Formation is composed of shales and carbonate interbeds. The chalk unconformably overlies the Abu Roash Formation or Bahariya Formation and unconformably underlies the Lower Eocene to Oligocene rock units.

3.2. Abu roash formation (Late Cenomanian – Santonian)

It conformably overlies the Bahariya Formation and unconformably underlies the Khoman Formation. The formation is divided into seven informal members designated from bottom to top: G, F, E, D, C, B and A. Members B, D and F are relatively pure carbonate, whereas A, C, E and G members are largely fine clastics. The Abu Roash Formation was deposited in an open shallow marine shelf during several sedimentary cycles [12].

3.3. Bahariya formation (Early Cenomanian)

It consists of glauconitic and pyritic sandstone interbedded with shales, siltstones and carbonates [13]. It conformably overlies the Kharita Formation and underlies the Abu Roash Formation. Bahariya Formation was deposited under fluvio-marine environment in the Western Desert [13].

3.4. Kharita formation (Early Cretaceous – Albian)

It consists of sandstone and a few shale interbeds of shallow marine origin that extends over most of the Western Desert [3]. It conformably overlies the Dahab Formation and

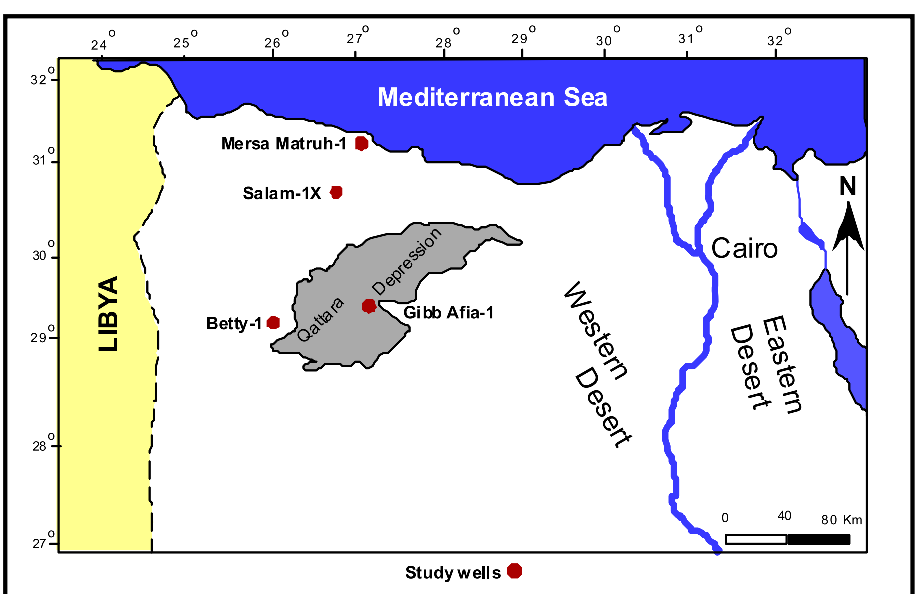

Figure 1 Location map of the studied wells.