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Jurassic–Cretaceous palynomorphs, palynofacies, and petroleum potential of the Sharib-1X and Ghoroud-1X wells, north Western Desert, Egypt

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ABSTRACT

Palynomorph and palynofacies analyses have been performed on 93 cutting samples from the Jurassic Masajid Formation and Cretaceous Alam El Bueib, Alamein, Dahab, Kharita, and Bahariya formations in the Sharib-1X and Ghoroud-1X wells, north Western Desert, Egypt. Two palynological biozones are proposed for the studied interval of the Sharib-1X well: the *Systematophora penicillata–Escharisphaeridia pocockii* Assemblage Zone (Middle to Late Jurassic) and the *Cretacaeiporites densimurus–Elateroplicites africaensis–Reyrea polymorpha* Assemblage Zone (mid-Cretaceous: late Albian to early Cenomanian). Spore coloration and visual kerogen analysis are used to assess the thermal maturation and source rock potential. Mature oil prone to overmature gas prone source rocks occur in the studied interval of the Sharib-1X well, whereas highly mature to overmature gas prone source rocks occur in the studied interval of the Ghoroud-1X well.

Palynofacies and palynomorph assemblages in both wells reflect shallow marine conditions throughout the Jurassic and the late Albian and early Cenomanian. During these times, warm and dry climatic conditions prevailed. The Cretaceous palynomorph assemblages of the Sharib-IX well correlate with the Albian–Cenomanian Elaterates Province of Herngreen et al. (1996).

1. Introduction

Since the 1960s, Egyptian researchers have concentrated on the classical taxonomic, palynostratigraphic and paleoenvironmental aspects of palynology in their studies. Only during the past 15 years they started to pay attention to the more applied sides such as organic thermal maturity and source rock potential (e.g. Ibrahim, 1996, 2002a; Ibrahim et al., 1997). This trend has even increased in the past five years with the recent and ongoing work of El Beialy et al. (2008, 2010) and Zobaa et al. (2008, 2011) which integrated other tools such as stable isotope and organic geochemical analyses. The present study continues this trend by focusing on the hydrocarbon potential of the subsurface Jurassic and Cretaceous sequence in the north Western Desert of Egypt, where there are many oil discoveries (Schlumberger, 1995).

Two wells located in the north Western Desert of Egypt, the Sharib-1X (30°11'36" N, 28°19'06" E) and Ghoroud-1X (30°03'08" N, 28°19'15" E) (Fig. 1), were studied. Although the Sharib-1X well reached a total depth of 8205 ft (2501 m; WEPCO, 1971), our palynological investigation was restricted to the 6160–5360 ft (1878–1634 m) interval. Omran et al. (1990) studied five samples from the Sharib-1X well, three of which were from an interval older than that of our study. These authors focused on palynostratigraphic and paleoenvironmental implications, and did not attempt to characterize the kerogen contents of their samples. The Ghoroud-1X well reached a total depth of 10384 ft (3165 m; WEPCO, 1970) and our investigation was restricted to the 9810–6440 ft (2990–1963 m) interval. This interval was also studied by Mahmoud and Moawad (1999) who recognized two informal palynomorph zones of Albian and early Cenomanian age and discussed the paleoenvironmental conditions. They did not present any palynofacies data in their study which is augmented in the present study.

The objectives of the present study for both wells were to: (1) identify the palynofacies types and determine possible source rock horizons, (2) use spore coloration to evaluate the thermal maturity of the samples studied, and (3) provide insights into the depositional paleoenvironments. In addition, the Sharib-1X well was studied to establish biostratigraphic zonations.

2. Materials and methods

The present study is based on 66 cutting samples from the Sharib-1X well and 27 cutting samples from the Ghoroud-1X well in the Egyptian north Western Desert. The samples were prepared using standard maceration techniques that included demineralizing the samples with HCl and HF, and sieving the residue at 125 μm and 10 μm. The residues were not oxidized or stained

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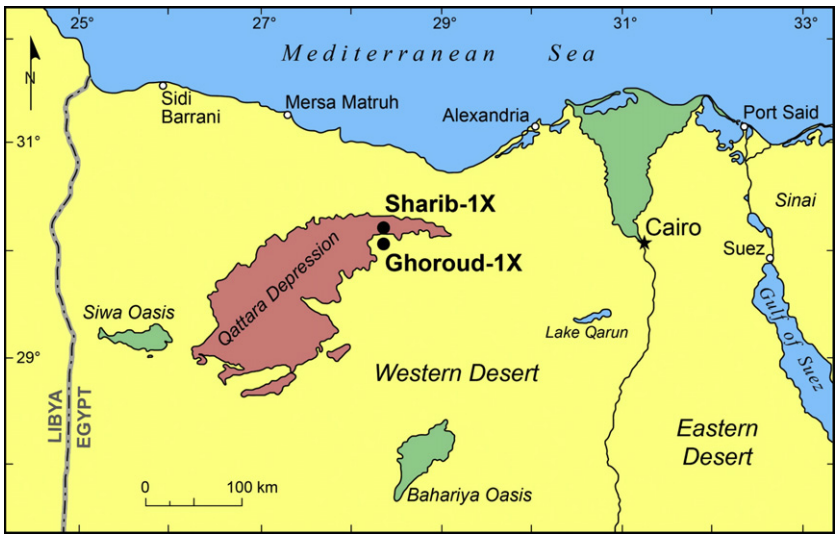

Fig. 1. Generalized map of northern Egypt showing the locations of the Sharib-1X and Ghoroud-1X wells (modified from Ibrahim, 2002b).

since this would have hindered the study of kerogen particles and spore coloration. Prepared slides were examined under transmitted light microscopy at variable magnifications to generate qualitative and semi-quantitative data for the particulate organic matter (POM). A total of 200 palynomorph specimens and 200 kerogen particles were counted for palynostratigraphic and palynofacies studies, respectively. All slides and residues are stored and catalogued in the Paleontology Research Laboratory, Geology Department, Faculty of Science, Benha University, Egypt.

3. Lithostratigraphy

The studied intervals in the Sharib-1X and Ghoroud-1X wells represent the Jurassic Masajid Formation and Cretaceous Alam El Bueib, Alamein, Dahab, Kharita, and Bahariya formations (Figs. 2 and 3). The lithologies, unit thicknesses, and tops of these formations are discussed below, following WEPCO (1970, 1971) and Schlumberger (1995). It is evident that the Masajid Formation is missing from the Ghoroud-1X well, whereas the Alam El Bueib, Alamein and Dahab formations are absent in the Sharib-1X well.

3.1. Jurassic

The Jurassic is represented only by the Masajid Formation in our study. Its type section as defined by Al Far (1966) is located at Gebel Maghara in the Egyptian Sinai Peninsula where it is 1886 ft (575 m) thick and is composed mainly of coralline limestone with clay and sandstone beds. Keeley et al. (1990) redefined the Masajid Formation as a more carbonate-dominated interval. In the present study, the Masajid Formation consists mainly of medium to hard dolomite with shale interbeds, changing downsection to alternating beds of cryptocrystalline medium to hard sandy to silty limestone, white calcareous sandstone, and brown fissile calcareous shales. It occurs at the base of the studied interval in the Sharib-1X well, where it unconformably underlies the Kharita Formation (Fig. 2). The studied interval of the Masajid Formation in this well is 205 ft (62 m) thick, and occurs at a depth of 6171–5966 ft (1881–1818 m).

3.2. Cretaceous

The subsurface Cretaceous in the Western Desert is separated from the underlying carbonate Masajid Formation by a major regional unconformity. The Cretaceous deposits comprise mainly fine- to coarse-grained clastics, and are subdivided from base to top into the Alam El Bueib, Alamein, Dahab, Kharita, and Bahariya formations (Schlumberger, 1995).

3.2.1. Alam El Bueib Formation

The main constituents are friable fine- to medium-grained sandstone with dark gray to brownish gray silty shale interbeds (Fig. 3). The examined interval is 1827 ft (557 m) thick in the Ghoroud-1X well, occurring at a depth of 9850–8023 ft (3002–2445 m).

3.2.2. Alamein Formation

This consists mainly of hard dense brown dolomite with a few thin shale interbeds at the base and top (Fig. 3). It has a thickness of 188 ft (57 m) in the Ghoroud-1X well, occurring at a depth of 8023–7835 ft (2445–2388 m).

3.2.3. Dahab Formation

Shale with minor limestone interbeds are mainly represented (Fig. 3). This unit has a thickness of 15 ft (4.5 m) in the Ghoroud-1X well and occurs at a depth of 7835–7820 ft (2388–2384 m).

3.2.4. Kharita Formation

This is represented by coarse-grained slightly calcareous (at base) sandstone of varying color with greenish to dark gray fissile calcareous shale interbeds in the Sharib-1X well (Fig. 2). In the Ghoroud-1X well it consists of quartzitic fine- to medium-grained anhydritic sandstone at the top and occasionally fine- to coarse-grained sandstone with calcareous or anhydritic matter associated with dark gray micaceous shale interbeds at base (Fig. 3). It rests unconformably above the Masajid Formation in the Sharib-1X well and conformably above the Dahab Formation in the Ghoroud-1X well. In the Sharib-1X well, the Kharita Formation attains a thickness of 539 ft (164 m) and occurs at a depth of 5966–5427 ft (1818–1654 m), whereas in the Ghoroud-1X well it is 705 ft thick (215 m) at a depth of 7820–7115 ft (2384–2169 m).

3.2.5. Bahariya Formation

This formation was defined by Said (1962) and El Akkad and Issawi (1963). Its type section is 567 ft (173 m) thick, and is located at Gebel El Dist in the Bahariya Oasis, Western Desert. The Bahariya Formation comprises medium- to coarse-grained sandstone with calcareous silty shale interbeds in the Sharib-1X well (Fig. 2). In