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Petrophysical and petrographic evaluation of Sidri Member of Belayim Formation, Badri field, Gulf of Suez, Egypt

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ABSTRACT

Presence of sandstone streaks in Sidri Member within Belayim Formation that lies between two productive zones; Kareem Formation and Hammam Faraun Member, was the main reason to perform this study. It may represent a good hydrocarbon reservoir and will be added to the Egyptian oil production in some wells of Badri field. This Member has high resistivity signature on Electric-logs responses which attracted the attention to investigate its occurrence in the field, to delineate its distribution all-over the area, to evaluate the petrographic and petrophysical characteristics and to evaluate its productivity. Petrographic and petrophysical analyses of these sand zones were undertaken using thin section samples. The electric logs and subsurface geologic data was used to evaluate the main reservoir characteristics of the Sidri sandstone such as lithology, cementation, shale volume, porosity (Φ), effective porosity (Φ_{eff}), estimated permeability (K), fluid saturation, fluid type and Net pay thickness.

This study revealed that, Sidri sandstone facies was classified into two mainly sandy facies; blocky sandy facies which located at the northern part of the field and streaky sandy facies at the southern area of the field. These two facies are separated by shaley facies. Some wells were studied to represent the two sandy facies in Sidri Member and these sand intervals have not been tested yet. These sands consist of quartz grains with grey and pink feldspars as accessory minerals, with siliceous and calcareous cementation, with good porosity. Petrophysical evaluation of this sand unit indicated that it is hydrocarbon bearing formation in three wells and water bearing one in other wells. Electrical logs analysis (Resistivity, Density-Neutron, Sonic and Gamma-Ray) revealed that The volume of shale in this sandstone, the effective porosity, the water saturation, the estimated permeability, the hydrocarbon saturation, and the net-pay thickness are varying from 9 to 13%, 19%–22%, 26%–34%, 200 and 600 mD, 66 and 74%, 20–35 feet respectively. The fluid types are oil, gas and water.

1. Introduction

More detailed and comprehensive studies are needed to achieve a better understanding of the promising areas, in which detailed examinations of Sidri Member all-over the Gulf of Suez, such as the distribution of Sidri sandstone in Morgan and Badri fields and the nearest Fields are needed, and carrying out a depositional model for further exploration in the Gulf of Suez to delineate the distribution of this promising reservoir and to determine the new areas, which have a good possibility for more sand reservoirs all-over the Gulf of Suez. Alsharhan and Salah (1994) mentioned that, we must keep looking for stratigraphic traps in the southern Gulf of Suez.

The main purpose of this study is; 1-delineating of the distribution of Sidri (s.s) Member in the Badri Field, 2- investigation of the main its petrographic and petrophysical characteristics within Belayim Formation, 3- investigating the hydrocarbon accumulations within it. This target was achieved using petrographic analysis of the thin sections for the ditch samples, and through petrophysical analysis of manual and sophisticated computer software of available well logging data. The petrographic characteristics include lithology determination, matrix types, grain size, sorting, identification of primary minerals, accessory minerals, type of cementation, visual porosity and oil shows. The detected petrophysical characteristics are shale content (V_{sh}), effective porosity ($Ø_{eff}$), permeability (K), water saturation (S_w), hydrocarbon saturation (S_{hr}) and Net-pay thickness.

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1.1. Location of the study area (Badri Field)

Badri Field lies in the offshore part of Gulf of Suez and covers an area of about 12 km It is located at 625 m northeast of Morgan Field. Badri Field is located in the southern province of the Gulf of Suez, approximately 20 km northeast of Ras Shukheir Town. The area under investigation is located in the southern part of the Gulf of Suez of Egypt, immediately 60 km south of the Mediterranean coast, 270 km North-west of Cairo and about 15 km, North-west of Al-Tor City. It is bounded by latitudes 33° 22′ and 34° 47′ N, and longitudes 28° 24′ and 28° 26′ E (Fig. 1).

Badri field lies east and directly adjacent to North of Morgan field. The Production is primarily from the clastic Hammam Faraun Member of the Belayim Formation and from clastic Kareem Formation These two reservoirs are belonging to Middle Miocene. Badri Oil Field is one of the most prolific oil and gas fields in the Gulf of Suez, with a large cumulative production.

Among many drilled wells scattered within the area, BDR-B9, BDR-A14 BDR-E13, BDR-D8A and BDR-C14 wells were selected to show the distribution of Sidri sandstone within the field where it varies from streaky sands to blocky sands and disappears and is replaced by shaley facies in some parts. Also, these selected wells show differences in the petrophysical parameters which were selected for the estimation of hydrocarbon potentiality of subsurface reservoir in Badri field.

1.2. Generalized geologic setting

The main structure of Badri Field is the anticline fold which trending NW-SEwith approximately four hundred fifty feet of closure at the top of Belayim Formation (Alsharhan, 2003). The entire features are bounded to the east by a major NW–SE trending normal fault, NE dipping fault with an estimated twelve hundred feet of throw at the top of Belayim unconformity. This Juxtaposes the Belayim reservoir against the sealing South Gharib Evaporites. To the West, Badri area is bounded and separated from the North EL Morgan by a NW–SE trending normal fault, dipping NE with an average two hundred fifty feet of throw at the top of Belayim

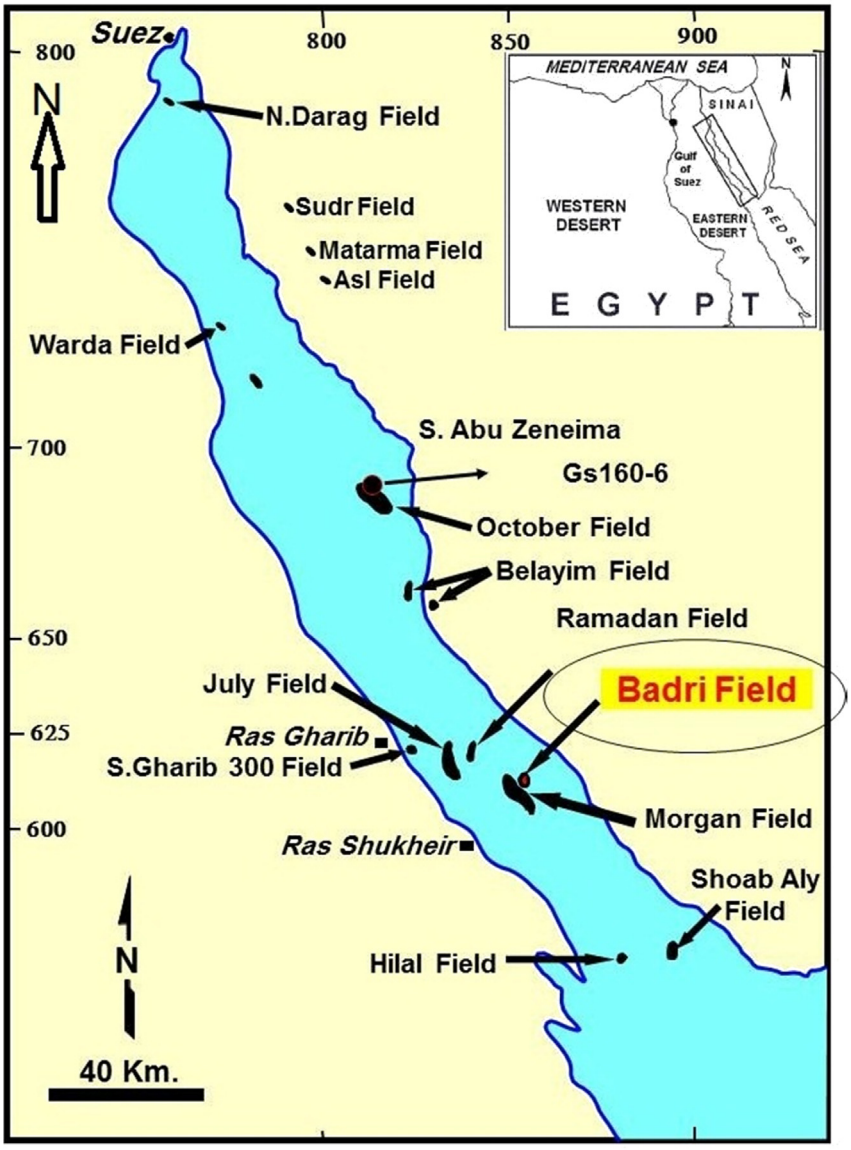

Fig. 1. location map of the study area in the Gulf of Suez where the main oil fields in the Gulf of Suez were illustrated.