Egyptian Journal of Petroleum xxx (2016) xxx–xxx

HOSTED BY

Contents lists available at ScienceDirect

Egyptian Journal of Petroleum

journal homepage: www.sciencedirect.com

Full Length Article

Reservoir characterization utilizing the well logging analysis of Abu Madi Formation, Nile Delta, Egypt

M. Mahmoud [a], M. Ghorab [b], T. Shazly [b], A. Shibl [a], Abeer A. Abuhagaza [b,*]

[a] Ain Shams University, Egypt
[b] Egyptian Petroleum Research Institute, Egypt

ARTICLE INFO

Article history:
Received 24 October 2016
Revised 8 November 2016
Accepted 13 November 2016
Available online xxxx

Keywords:
Reservoir characterization
Late Miocene
Abu Madi Formation
Well logging
Abu Madi/El Qar'a fields

ABSTRACT

The petrophysical evaluation of the Late Miocene Abu Madi Formation were accomplished based on the open hole logs of eighteen wells in Abu Madi–El Qar'a gas fields, onshore Nile Delta, Egypt. The lithological contents of this rock unit were analyzed using the cross plots of petrophysical parameters including shale volume, porosity and hydrocarbon saturation. The neutron /density cross-plots, M-N and RHOMAA–DTMAA and litho-saturation cross plots of the studied wells show that the main lithology of the lower part of Abu Madi Formation is calcareous sandstones with shale intercalations in most of the studied wells while its lithology is mainly shale with sand intercalations in wells AM-13, AM-21 and AM-7. The lithology of the upper part of Abu Madi Formation in most wells is composed mainly of shale while its lithology in AM-13, AM-21 and AM-7 wells is composed of sandstone with shale intercalations. The thorium-potassium cross plots indicate that, Abu Madi Formation was deposited mostly in fluvial to shallow marine environments according to the presence of mica and illite in the southern area and montmorillonite at the northern area as dominant clay minerals. Contour maps of several petrophysical parameters such as effective thickness, average shale volume, average porosity and hydrocarbon saturation showed that both lower and upper parts of Abu Madi Formation in the study area have promising reservoirs characteristics; in which the prospective area for gas accumulation located toward the central part.

1. Introduction

The Nile Delta is situated near to the northeastern margin of the African plate and forms part of the Eastern Mediterranean basin. The Nile Delta is a giant gas province that has attracted attention due to its approximately 42 TCF of proven reserves and approximately 50 TCF of undiscovered potential. Following the first commercial discovery in 1966 when the Abu Madi-1 well proved the production potential of the Messinian Abu Madi sandstones [1], exploration on the onshore Delta has focused on Oligocene/Early Miocene through Pleistocene clastic reservoirs. The study is focused on the Abu Madi and El Qar'a gas fields, these fields are the giant gas fields located in the northern part of the NileDelta; southeast of Lake Burullus about 200 km north of Cairo city (Fig. 1). El Qar'a Gas field was considered by [2] as an extension to the north of Abu Madi Field. In which the main target is the Late Messinian Abu Madi Formation [3]. This study involves lithology analysis of Abu Madi Formation based on logging parameter cross-plot by using logging data of 18 gas wells, and evaluation of petrophysical parameters such as shale content, porosity, water and hydrocarbon saturation.

2. Geological setting

The Nile Delta lies on unstable shelf characterized by thick sedimentary section covering the high basement relief due to block faulting. [4] showed that the North Nile Delta basin is structurally controlled by three main fault trends; 1 – NW–SE fault trend, 2 – NE–SW fault trend and 3 – E–W fault trend. The interplay of these fault trends builds up the overall tectonic framework of north Nile Delta basin (Fig. 2).

The sedimentary section in the Nile Delta area with gas potentiality seems to be limited to the Neogene formations trapped against listric faults or draped over tilted fault blocks. However

Peer review under responsibility of Egyptian Petroleum Research Institute.
* Corresponding author.
E-mail address: aaa_geo107@yahoo.com (A.A. Abuhagaza).

http://dx.doi.org/10.1016/j.ejpe.2016.11.003
1110-0621/

Please cite this article in press as: M. Mahmoud et al., Reservoir characterization utilizing the well logging analysis of Abu Madi Formation, Nile Delta, Egypt, Egypt. J. Petrol. (2016), http://dx.doi.org/10.1016/j.ejpe.2016.11.003

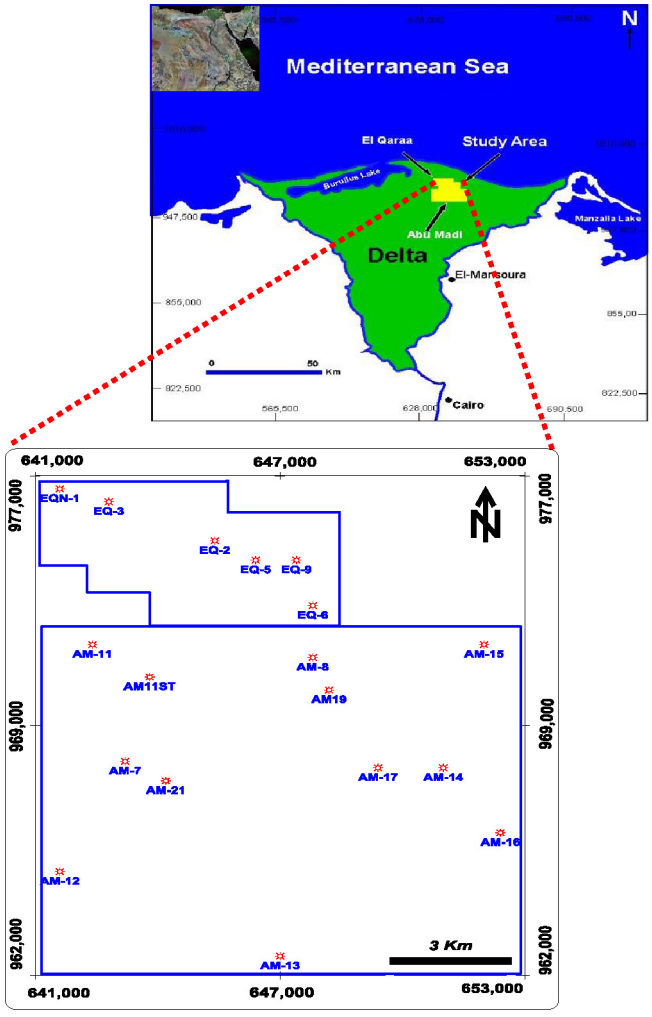

Fig. 1. Location map of the study area.

Pre-Miocene formations of the base of this Neogene sequence may also be considered as future exploration plays. Mesozoic reservoirs are present at greater depth and have been only penetrated by a few wells which are mostly located in the south delta block. The sedimentary rocks penetrated in Abu Madi/El Qar'a fields consist of thick clastics representing Miocene-Holocene time interval. These rocks were described by [5,6]. The studied section is differentiated into the rock units: Qantara, Sidi Salem, Qawasim, and Abu Madi formations of the Miocene age; Kafr El Sheikh and El Wastani formations of the Pliocene age; Mit Ghamr Formation of late Pliocene-Pleistocene age and the Bilqas Formation of recent age. All these formations consist essentially of clastic sediments (shale, sand, and silt).

3. Materials and methods

The hydrocarbon saturation of Abu Madi reservoirs in the studied area was evaluated in eighteen wells from south to north (AM-13, AM-12, AM-16, AM-21, AM-17, AM-14, AM-7, AM-19, AM-11ST, AM-11, AM-8, AM-15, EQ-2, EQ-3, EQ-5, EQ-6, EQ-9, and EQN-1). The basis for reservoir oil and gas potentiality evaluation is the petrophysical analysis of drilled targets in all the wells, including the vertical distribution of petrophysical parameters, lithology interpretation from parameters cross plots and lateral distribution changes of various parameters. The available 1og data for the studied units in all the wells were quality control inspected, including deep and shallow laterologs (LLD, ILD, LLS, LLM and MSFL), neutron porosity, bulk density, acoustic and gamma ray. The borehole environmental corrections and interpretation were carried out using Schlumberger software TECHLOG (2011.2.1). The lithology components of Abu Madi Formation in all wells were investigated by using crossplots of logging parameters (including dia-porosity density–neutron cross-plots, and tri-porosity M-N and rhomaa–dtmaa crossplot), the results from different crossplots are slightly different according to the properties of each parameter.

Shale content (Vsh) may be evaluated using a variety of petrophysical indexes, such as gamma-ray, neutron porosity, resistivity and neutron porosity/density as a double curve clay indicator [7]. In the present study the corrected porosity was estimated using a combination of the density and neutron logs [8]. The effective water saturation (Sw) in clean and shaly zones was computed using the Indonesia [9]. Determination of the hydrocarbon saturation (Sh) and discrimination of hydrocarbons into the different types of gas or oil are performed.

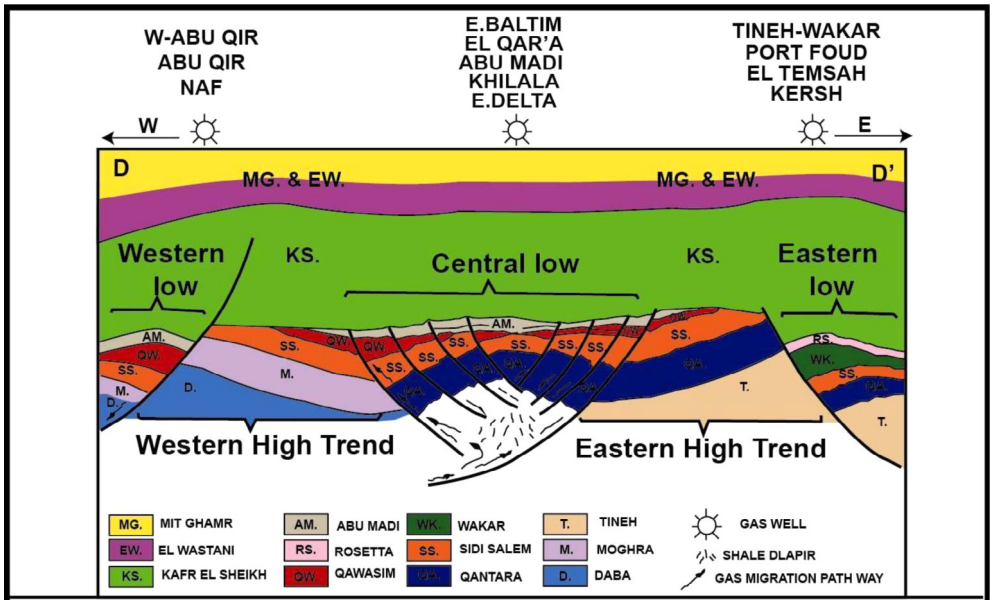

Fig. 2. Geological model of the North Nile Delta block after [4].

Please cite this article in press as: M. Mahmoud et al., Reservoir characterization utilizing the well logging analysis of Abu Madi Formation, Nile Delta, Egypt, Egypt. J. Petrol. (2016), http://dx.doi.org/10.1016/j.ejpe.2016.11.003