Radiogenic Heat Production and Reservoir Properties of Rudeis Formation in Belayim Marine Oil Field, Gulf of Suez, Egypt

By

Hassan Badr Eldin Hassan Mohamed
(Demonstrator in Geophysics Department, Nuclear Materials Authority)

A thesis submitted in partial fulfillment of the requirements for the degree

of

Master of Science

In Geophysics

Under supervision of

Prof. Dr. Nasser Mohamed Hassan Abou Ashour
Professor of Geophysics, Geophysics Department,
Faculty of Science, Ain-Shams University

Prof. Dr. Refaat Ahmed El-Terb
Professor of Geophysics, Geophysics Department,
Exploration Division, Nuclear Materials Authority

Dr. Ayman Shebl Elsayed Sayed Ahmed
Lecturer of Geophysics, Geophysics Department,
Faculty of Science, Ain-Shams University

Geophysics Department

Faculty of Science

Ain-Shams University

2014

دراسة الحرارة الناتجة من النشاط الاشعاعى وخصائص الخزان لتكوين روديس بحقل بترول بلاعيم بحرى، خليج السويس، مصر

رسالة مقدمة من

حسن بدر الدين حسن محمد

معيد بقسم الجيوفيزياء

هيئة المواد النووية

لاستكمال متطلبات الحصول على درجة

الماجستير

فى الجيوفيزياء

تحت إشراف

أ. د / ناصر محمد حسن ابو عاشور

أستاذ الجيوفيزياء- قسم الجيوفيزياء

كلية العلوم – جامعة عين شمس

أ.د / رفعت أحمد ابراهيم الترب

أستاذ الجيوفيزياء التطبيقية- قسم الجيوفيزياء

قطاع الاستكشاف – هيئة المواد النووية.

د / ايمن شبل السيد سيد أحمد

مدرس الجيوفيزياء- قسم الجيوفيزياء

كلية العلوم – جامعة عين شمس.

قسم الجيوفيزياء

كلية العلوم

جامعة عين شمس

2014

APPROVAL SHEET

TITLE OF THE MASTER THESIS

"Radiogenic Heat Production and Reservoir Properties of Rudeis Formation in Belayim Marine Oil Field, Gulf of Suez, Egypt"

BY
Hassan Badr El-dine Hassan Mohamed

The Thesis for Master Degree has been approved

By

ACKNOWLEDGEMENT

First and foremost, I give **Allah** the glory that made this work to complete. I would like to express the deepest appreciation to ***Prof. Dr. Nasser Mohamed Hassan Abou Ashour***, Prof. of Geophysics, Ain-Shams University, who has the attitude and substance of a genius, he continually and convincingly conveyed a spirit of adventure in regard to research and also provides a constructive criticism and invaluable advice.

I'm deeply indebted and special thanks to ***Prof. Dr. Refaat Ahmed El-Terb***, prof. of applied Geophysics, Well logging Department, Exploration division, Nuclear Materials Authority, for his support, helpful discussions and being a great teacher, but no words of thanks and feelings are sufficient.

My sincere thanks to ***Dr. Ibrahim El-Alfy***, lecturer of Geophysics, Nuclear Materials Authority for his guidance in data processing and software instructions. Without his guidance and persistent help this dissertation would not have been possible. The constructive comments, criticism from ***Dr. Ayman Shebl El-Sayed Sayed Ahmed***, lecturer of Geophysics, Ain-Shams University is greatly appreciated. Also special thanks to all **staff members in NMA**, for their kind co-operation for the completion of my work.

Furthermore, I wish to thank Petrobel Petroleum Company for providing the well logging data needed for this research**.**

Last but not least, I am forever indebted to **My Parent**, to **My Wife,** to **My Daughter Talia** and to **My families**, for their understanding and endless love, through the duration of my studies.

Hassan Badr El-din Hassan Mohamed

CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABSTRACT

This thesis commences with an overview of the Stratigraphy and geological setting of the study area with more emphasis about the area under consideration. In the study area, the Rudeis Formation is recoded in all wells BM-30, BM-35, BM-37, BM-57, BMNW-2, BMNW-3, 113-M-27, 113-M-34, and 113-M-81. Thickness varies between 134 m in BM-30 to 615 m in BM-35, and lithologically Rudeis Formation consists mainly of sandstones with little shale.

The study is primarily based on borehole logging data. The objectives of this study were to estimate the Radiogenic Heat Production from two different sets of data, radioactive characteristics and evaluate the reservoir properties of Rudeis Formation Rocks in Belayim marine oil field, Gulf of Suez, Egypt. The available data include well logging data of nine wells, seven of them possessed spectral gamma-ray log data (SGR) of the Rudeis Formation rocks in the study area.

The distributions of each radioactive element in the Rudeis Formation rocks were analyzed by two methods, the statistical analysis and histogram. The thorium-potassium cross plots for all seven wells are presented in order to identify the clay minerals in the Rudeis Formation rocks. The main clay minerals in Rudeis Formation of the studied wells consist of montmorillonite, kaolinite, chlorite and mixed clay layer with some traces of illite and glauconite clay minerals. The radiometric studies of the Rudeis rocks in the study area show that, the concentration of radioactive minerals is in the normal range.

Radiogenic heat production estimated from the concentrations of the radioactive elements and gamma-ray intensity obtained from SGR, and GR logs respectively recorded in the Rudeis Formation, and a 3D block of radiogenic heat production was constructed from those two sets of data.

Plotting the reservoir RHP in the form of 3D gives a clear picture about the distribution of Radiogenic Heat production in all parts of the Rudeis Formation in the study area. The north and northeastern parts of the study area have showed the highest radiogenic heat production than the other parts.

Heat production estimated from gamma-ray Intensity was moderately correlated with those estimated from the concentrations of radioactive elements. The average radiogenic heat generation produced from the study area is calculated as 1.2 KW.

Abstract

A considerable amount of geological information required for subsurface reservoir characterization of new and old hydrocarbon fields can be attained by analyzing critically well logging data.

Digitizing, gathering well logging data and applying environmental corrections are important to give an accurate log analysis as well as to generate vertical lithological logs of the subsurface. Multiwell normalization is necessary to ensure that the results are accurate, consistent and comparative from well to well, by using histograms. Iso-parameter maps for estimating the clay volume, porosity, net pay thickness, water saturation, hydrocarbon saturation, oil in place and pie charts were prepared for use in predicting the distribution of reservoir properties in Rudeis Formation.

These maps in addition to the decision map provide a quick method of estimates hydrocarbon field. The study yields important reservoir parameters which can assist reservoir engineers for further development and enhance oil recovery (EOR).

CHAPTER- 1

INTRODUCTION

This chapter deals with the previous work on the study area (Belayim marine oil field) which is located between Latitudes 28° 34` 45`` - 28° 38` 32`` N and Longitudes 33° 05` 17`` - 33° 10` 38`` E in the eastern side of the Gulf of Suez, 165 kms southeast of Suez city. The field covers an area of about 9 km^2 when discovered in 1961, but with more exploration the field covers now an area more than 25 km^2 at the west of Sinai shoreline (Fig. 1-1).

Fig (1-1) shows a location map for wells of the study area. The main goal for the present study is to contribute, through well logging analysis to the reservoir characterization of the Lower Miocene section with special reference to Rudeis Formation in this area for more development and exploration activities.

Well logging data were obtained from the Egyptian General Petroleum Corporation (EGPC) and the Belayim Petroleum Company (Petrobel). Nine well logs which represent the Lower Miocene rocks were available for this Study, subsurface total count gamma-ray (GR) data were recorded in all nine wells, and seven of them possessed spectrometric data. Equivalent uranium log, equivalent thorium log and potassium percent log were used to study the radioactive properties and estimate radiogenic heat production of the Rudeis Formation rocks in Belayim marine oil field.

Spectrometric data play a very important role in reservoir evaluation because it gives a good idea about the rock radiation and rocks lithology.