

**Petrophysical Analysis of Ziarat Well#1, Baluchistan, Central Indus
Basin Using Wireline Log Data**



By

**Muhammad Abdullah Khan
Qasim Ali Khan
Syed Muhammad Zain Bukhari**

**Department of Earth and Environmental Sciences
Bahria University, Islamabad**

2012

ACKNOWLEDGEMENTS

This dissertation would not have been possible without the guidance and the help of several individuals who in one way or another contributed and extended their valuable assistance in the preparation and completion of this study.

A million of thanks to the one above all of us, the omnipresent Allah Almighty, for answering our prayers for giving us the strength to plod on despite our constitution wanting to give up and throw in the towel, thank you so much Dear Lord.

A heatedly thanks to our beloved parents; who all have always been there to make this happen and for being there in every walk of life to make us stand where we were today.

First and foremost, utmost gratitude to our Supervisor, Mr. Muhammad Zahid, whose sincerity and encouragement, we will never forget. Along with all the encouragement, guidance and support from the initial to the final level enabled us to develop an understanding of the subject.

Dr. Muhammad Zafar, Head of the Department of Earth & Environmental Sciences, who, until the finalizing of the thesis had the moral support, kind concerns and consideration regarding our academic requirements.

Mr. Saqib Mehmood, co-supervisor, for his patience and steadfast encouragement to complete this study.

The staff of the department especially Mr. Imtiaz Hussain, Mr. Ashfaq and Mr. Azad for being accommodating to our queries and their assistant for all the help in the administrative works.

ABSTRACT

The main purpose of the study is to evaluate hydrocarbon potential of the study area, in a part of Upper Indus basin i.e. Qazian oil field and delineation of potential leads for future prospects. This has to be done by the analysis of 2-D seismic and wire line log data, which have been provided by Landmark, Pakistan with the permission of Directorate General of Petroleum Concessions, Islamabad, Pakistan. This data set comprises with 5 seismic lines and a complete suite of wire line logs of Qazian Well 1-X.

The methodology adopted to accomplish this task include; petrophysical analysis. Analysis of wire line logs includes the calculation of different reservoir characteristics like Shale Volume (V_{sh}), Sand Volume (V_{snd}), Porosity (Φ), Resistivity of True Formation (R_t), Density (ρ_B), Water Saturation (S_w), Hydrocarbon Saturation (S_{hc}) etc., using different available Logs such as Gamma Ray, Compensated Neutron LLD, LLS, Microspherically Focused Log, Litho Density Log, Sonic Log and Spontaneous Potential Log. These measured Parameters, then, used further for reservoir potential evaluation.

The results computed from all above mentioned analysis of the data was used for the integrated study regarding reservoir characterization of the area under study.

CONTENTS

ACKNOWLEDGEMENTS	i
Abstract	ii
Chapter 1 Introduction	
1.1 Introduction	1
1.2 Objective	4
1.3 Methodology	4
Chapter # 2_Regional Tectonic & Petroleum Prospect	
2.1 Regional Setting	5
2.2 Tectonic frame work of pakistan.....	5
2.3 Tectonic basins in pakistan	7
2.4 Indus basin.....	7
2.5 Generalized Stratigraphy of Southern Indus Basin	9
2.6 Source, Reservoir and Seal rocks of study area	13
2.6.1 Source rocks:	13
2.6.2 Reservoir Rocks.....	13
2.6.3 Seal rock	13
Chapter#3 Wire line Logging & Bore Hole Environment	
3. BORE hole environment	15
3.1 BORE hole condition.....	15
3.1.3 Mud cake.....	16
3.1.4 Mud filtrate	16
3.2 Invasion.....	16
3.2.2 Invasion profile	17
3.3 Wire line logging / Well logging	18

3.5	Classification of logging tools.....	20
3.6	Electrical logs	21
3.6.1	Normal resistively log.....	21
3.7	Spontaneous potential log (sp).....	22
3.7.1	The Natural Gamma Ray Spectrometry Log	23
3.8	Porosity logs	23
3.8.1	Neutron log	23
3.8.2	Density log.....	25
3.8.3	Sonic log	26
Chapter # 4 Methodology		
4.1	Interpretation work flow	31
4.2	Petrophysical techniques.....	32
4.3	Pickett plots.....	32
4.3.1	Determination of Cementation Exponent "m" from Core	33
4.3.2	Determination of Saturation Exponent "n" from Core	34
4.4	Petrophysical Parameters	34
4.4.1	Porosity.....	34
4.4.2	Permeability	35
4.5	Water Saturation.....	36
4.6	Volume of Shale	37
4.6.1	Determination of Volume of Shale.....	37
Chapter # 5 Interpretation		
5.1	Petrophysical Interpretation.....	39
Conclusion		52
References.....		53

List of Figures

Fig 1.1 Location Map of Study Area	3
Fig 1.2 Work flow chart.....	4
Fig 2.1 Collision of Indian plate with Tibetan plate and formation of Himalaya.....	5
Fig 2.2 Tectonic Zones of Pakistan	7
Fig 2.3 Sedimentary basins of Pakistan.....	9
Fig 2.4 Stratigraphic Column of Central Indus Basin	14
Fig3.1 Invasion Profile.....	17
Fig 3.2 Logging Operation.....	19
Fig 3.8 Sonic log ray paths and recorded wave forms.....	28
Fig 3.9 Array sonic tool and waveforms.....	29
Fig 4.1 Work flow chart.....	31
Fig .5.1 Graphical representation of depth vs shale volume Zone A.....	40
Fig 5.2 Graphical representation of depth vs Effective Porosity Zone A.....	40
Fig 5.3 Graphical representation of depth vs Water saturation Zone A.	41
Fig 5.4 Graphical representation of depth vs Saturation of hydrocarbon Zone A.....	41
Fig 5.5 Graphical representation of depth vs Effective Porosity Zone B.	42
Fig 5.6 Graphical representation of depth vs shale volume Zone B.....	42
Fig 5.7 Graphical representation of depth vs Water saturation Zone B.	43

Fig 5.8 Graphical representation of depth vs saturation of hydrocarbon Zone B.....	43
Fig 5.9 Graphical representation of depth vs shale volume Zone C.....	44
Fig 5.10 Graphical representation of depth vs Effective Porosity Zone C.	44
Fig 5.11 Graphical representation of depth vs Water saturation Zone C.	45
Fig 5.12 Graphical representation of depth vs saturation of hydrocarbon Zone C.....	45
Fig 5.13 Graphical representation of depth vs shale volume Zone D.....	46
Fig 5.14 Graphical representation of depth vs Effective Porosity Zone D.....	46
Fig 5.15 Graphical representation of depth vs Water saturation Zone D.	47
Fig 5.16 Graphical representation of depth vs saturation of hydrocarbon Zone D.	47
Fig 5.17 Graphical representation of depth vs shale volume Zone E.....	48
Fig 5.18 Graphical representation of depth vs Effective Porosity Zone E.	48
Fig 5.19 Graphical representation of depth vs Water saturation Zone E.....	49
Fig 5.20 Graphical representation of depth vs saturation of hydrocarbon Zone E.....	49
Fig 5.21 Graphical representation of depth vs Total Porosity Zone F.....	50
Fig 5.22 Graphical representation of depth vs PorosityZone F.	50
Fig 5.23 Graphical representation of depth vs Water saturation Zone F.....	51
Fig 5.24 Graphical representation of depth vs saturation of hydrocarbon Zone F.	51