

**PROSPECT EVALUATION FOR PETROLEUM  
HYDROCARBON EXPLORATION USING  
GEOLOGICAL, GEOPHYSICAL AND WELL LOG  
DATA OF KANDRA AREA, MIDDLE INDUS BASIN,  
SINDH, PAKISTAN**



**By**

**MUHAMMAD ALI UMAIR LATIF**

**MUHAMMAD AWAIS**

**Department of Earth and Environmental Sciences**

**Bahria University, Islamabad**

**2012**

**PROSPECT EVALUATION FOR PETROLEUM  
HYDROCARBON EXPLORATION USING  
GEOLOGICAL, GEOPHYSICAL AND WELL LOG  
DATA OF KANDRA AREA, MIDDLE INDUS BASIN,  
SINDH, PAKISTAN**



A thesis submitted to Bahria University, Islamabad in partial fulfillment of the requirement for the degree of B.S in Geophysics

**MUHAMMAD ALI UMAIR LATIF**

**MUHAMMAD AWAIS**

**Department of Earth and Environmental Sciences**

**Bahria University, Islamabad**

**2012**

# CONTENTS

	<b>Page</b>
ACKNOWLEDGEMENTS	vii
ABSTRACT	viii
FIGURES AND GRAPHS	iv
LIST OF TABLES	v
ABBREVIATIONS	vi

## **CHAPTER 1 INTRODUCTION**

1.1	Introduction of the study area	1
1.2	Location of the study area	1
1.3	Objectives of the study	1
1.4	Methodology	2
1.5	Required data	3
1.6	Seismic data Information	3
1.7	Base map	4

## **CHAPTER 2 GEOLOGY AND TECTONICS OF THE AREA**

2.1	Tectonics of the study area	5
2.2	Geology of the study area	7

## **CHAPTER 3 PETROLEUM SUSTEM OF THE AREA**

3.1	Source	8
3.2	Reservoir	8
3.3	Seal	8
3.4	Trap	9

**CHAPTER 4**  
**STRATIGRAPHY OF THE AREA**

4.1	Stratigraphy and lithology of the study area	11
4.1.1	Sui Main Limestone	11
4.1.2	Chiltan Limestone	12
4.1.3	Ghazij Shales	12
4.1.4	Ranikot sandstone	12
4.1.5	Goru Formation	12

**CHAPTER 5**  
**SEISMIC DATA ACQUISITION AND PROCESSING**

5.1	Seismic data acquisition	15
5.2	Types of data Acquisition	15
5.2.1	Shot gather	15
5.2.2	Multiple shot points	16
5.3	Acquisition parameters	17
5.3.1	Source parameters	17
5.3.2	Receiver parameters	17
5.3.3	Recording parameters	18
5.3.4	Display parameters	18
5.4	Seismic data processing	18
5.4.1	Processing steps	19
5.4.2	Seismic data processing flow chart	20

**CHAPTER 6**  
**SEISMIC DATA INTERPRETATION**

6.1	Seismic data interpretation	21
6.2	Steps of Seismic Interpretation	22
6.2.1	Identification of reflections (tracing)	22
6.2.2	Picking and correlation of reflections	22

6.2.3	Continuity	23
6.2.4	Unconformities and seismic facies patterns	24
6.2.5	Fault pattern determination	25
6.2.6	Seismic lines interpretation	25
6.3	Average velocity graphs	31
6.4	Two-way travel time contour maps	33
6.5	Depth contour maps	39

## **CHAPTER 7**

### **PETROPHYSICAL ANALYSIS**

7.1	Petrophysics	45
7.2	Steps of petrophysical analysis	45
7.2.1	Identification of lithology	45
7.2.2	Marking of zones of interest	46
7.2.3	Calculation of volume of shale	46
7.2.4	Calculation of porosity	49
7.3.	Volumetric reserve calculation	60

<b>CONCLUSIONS</b>	61
--------------------	----

<b>REFERENCES</b>	62
-------------------	----

<b>APPENDIX</b>	63
-----------------	----

## FIGURES AND GRAPHS

	<b>Page</b>
Figure 1.1. Location map of Kandra area and block.	2
Figure 1.2. Base map of Kandra area.	4
Figure 2.1. Tectonic map of Pakistan showing Middle Indus Basin.	6
Figure 3.1. Petroleum system events chart for the Kohat-Potwar area including Kandra area.	10
Figure 4.1. Stratigraphic column of Middle Indus Basin.	13
Figure 5.1. Shot detector configurations used in multichannel seismic reflection profiling (a) Split spread, (b) End spread.	16
Figure 5.2. Data acquisition for reflection seismic using multiple shot points.	16
Figure 5.3. Seismic data processing flow chart.	20
Figure 6.1. Parallel other reflections.	24
Figure 6.2. Interpretation of seismic section for line KDR89-04.	26
Figure 6.3. Interpretation of seismic section for line KDR89-01.	27
Figure 6.4. Interpretation of seismic section for line KDR89-02.	28
Figure 6.5. Interpretation of seismic section for line KDR89-03.	29
Figure 6.6. Interpretation of seismic section for line KDR89-05.	30
Figure 6.7. Average velocity graph of KDR89-01.	31
Figure 6.8. Average velocity graph of KDR89-02.	31
Figure 6.9. Average velocity graph of KDR89-03.	32
Figure 6.10. Average velocity graph of KDR89-04.	32
Figure 6.11. Average velocity graph of KDR89-05.	33
Figure 6.12. Two-way travel time contour map on top of SML.	34
Figure 6.13. Two-way travel time contour map on top of Ranikot Formation.	35
Figure 6.14. Two-way travel time contour map on Top Lower Goru.	36
Figure 6.15. Two-way travel time contour map on top of Middle sand.	37
Figure 6.16. Two-way travel time contour map on top of Massive sand.	38
Figure 6.17. Two-way travel time contour map on top of Chiltan limestone.	39
Figure 6.18. Depth structure contour map of SML.	40
Figure 6.19. Depth structure contour map of Top Lower Goru.	41

Figure 6.20.	Depth structure contour map of Middle sand.	42
Figure 6.21.	Depth structure contour map of Massive sand.	43
Figure 6.22.	Depth structure contour map of Chiltan Limestone.	44
Figure 7.1.	Volume of shale variation with depth for Zone 1.	47
Figure 7.2.	Volume of shale variation with depth for Zone 2.	48
Figure 7.3.	Variation of average porosity with depth for Zone 1.	50
Figure 7.4.	Variation of effective porosity with depth for Zone 1.	51
Figure 7.5.	Variation of saturation of water with depth for Zone 1.	52
Figure 7.6.	Variation of saturation of hydrocarbon with depth for Zone 1.	53
Figure 7.7.	Average values for different factors with depth for Zone 1.	54
Figure 7.8.	Variation of average porosity with depth for Zone 2.	55
Figure 7.9.	Variation of effective porosity with depth for Zone 2.	56
Figure 7.10.	Variation of saturation of water with depth for Zone 2.	57
Figure 7.11.	Variation of saturation of hydrocarbon with depth for Zone 2.	58
Figure 7.12.	Average values for different factors with depth for Zone 2.	59

## LIST OF TABLES

	<b>Page</b>	
Table 1.1.	Information about seismic data.	3
Table 4.1.	Borehole stratigraphy of well Kandra-01.	14
Table 5.1.	Source parameters used in seismic survey of Kandra area.	17
Table 5.2.	Receiver parameters used in seismic survey of Kandra area.	17
Table 5.3.	Recording parameters used in seismic survey of Kandra area.	18
Table 5.4.	Display parameters used in seismic survey of Kandra area.	18
Table 7.1.	Zones of interest.	46
Table 7.2.	The volumetric reserve calculated for the study area.	60
Table 7.2.	Calculations in Zone 1.	63
Table 7.3.	Calculations in Zone 2.	64

## ABBREVIATIONS

LLD	Laterolog Deep
LLS	Laterolog Shallow
MSFL	Micro Spherically Focused Log
NMO	Normal Move Out
DMO	Dip Move Out
SP	Spontaneous Potential
Api	American Petroleum Institute
Vshale	Volume of Shale
GR	Gamma Ray
NMR	Nuclear Magnetic Resonance
H <sub>z</sub>	Hertz
M/sec	Meters per second
S <sub>h</sub>	Saturation of Hydrocarbon
S <sub>w</sub>	Saturation of Water
R <sub>w</sub>	Resistivity of Water
%	Percentage



## **ACKNOWLEDGEMENTS**

In the name of Allah, the most merciful and beneficent. From the depth of our heart we express our deep sincere gratitude to the Almighty for the Blessings He had bestowed upon us to do this work.

Foremost, we place on record our sincere gratitude to our respected external supervisor Mr. Yasir Khan Jadoon of Dewan Petroleum (Pvt.) Limited and internal supervisor Prof. Dr. Tahseenullah Khan, Department of Earth and Environmental Sciences, Bahria University, Islamabad. We are extremely grateful and indebted to them for their expert, sincere and valuable guidance and encouragement to us.

We are thankful to Dr. Muhammad Zafar, Head of Department, Earth and Environmental Sciences, for providing us the opportunity and making the department facilities available.

We would also like to thank our parents whose selfless sacrificial life and their great efforts and unceasing encouragement, support and prayers has enabled us to reach the present position in life.

## **ABSTRACT**

For the purpose of study of the area Kandra, five migrated seismic lines KDR89-01, KDR89-02, KDR89-03, KDR89-04, and KDR89-05 were acquired from Land Mark Resources by the permission of Directorate General Petroleum Concession (DGPC). The obtained data were consisting of two strike lines whereas one Strike line in North-East direction and other one in North-South direction. The remaining three seismic lines were dip lines in East-West direction. The acquired data also contains well log data. In this investigation petrophysical analysis and seismic data interpretation had been done.

Depth contour maps were generated with the help of marking of horizons and identification of faults on top of each prospective formation from which the knowledge about the tectonic activities and subsurface structures in the study area were calculated. Velocity contour maps were also generated on top of every prospective horizon.

Petrophysical analysis consisted of calculation of porosity, volume of shale, saturation of water and hydrocarbon by using log data of Kandra-01. Potential hydrocarbon reserves were estimated by using information of porosity, saturation of water/hydrocarbon and volume factor of reservoirs formation.