

2D Seismic Interpretation of Seismic Lines in  
Nandraki / Shakardara Area, Kohat Basin,  
Pakistan.



Muhammad Haroon  
Qasim Nisar  
Uzair Javed

Bs (Geophysics)

Department of Earth & Environmental Sciences,  
Bahria University, Islamabad.  
(2007-2011)

## TABLE OF CONTENTS

Abstract	i
Acknowledgements	ii
Chapter 1 <u>Introduction</u>	1
1.1 Physiography	1
1.2 Location of Area	2
1.3 Data Used	3
1.4 Plan of Study	4
Chapter 2 <u>General Geology</u> 5	5
2.1 Kohat-Potwar Plateau	5
2.2 Tectonic Setting of Kohat	7
2.3 Structural Setting of Kohat	7
2.4 Stratigraphy of the Area	9
2.4.1 Paleocene Sequence	10
2.4.1.1) Lockhart Limestone	10
2.4.1.2) Patala Formation	10
2.4.2 Eocene Sequence	10
2.4.2.1) Panoba Shale	11
2.4.2.2) Bahadur Khel Salt	11
2.4.2.3) Jatta Gypsum	11
2.4.2.4) Shekhan Formation	11
2.4.2.5) Mami Khel Clay	12
2.4.2.6) Kohat Formation	12
2.4.3 Miocene Series	12
2.4.3.1) Murree Formation	12
2.4.3.2) Kamlial Formation	13
2.4.4 Pliocene-Pleistocene Series	13
2.4.4.1) Chinji Formation	13
2.4.4.2) Nagri Formation	14
2.4.4.3) Dhok Pathan Formation	14
2.4.4.4) Soan Formation	14
2.5 Exploration History	16
2.6 Hydrocarbon Potential	16
2.6.1 Source Rock	16
2.6.2 Reservoir Rock	17
2.6.3 Traps and Seal	17
2.6.4 Burial History	17
Chapter 3 <u>Seismic Methods</u>	18
3.1 Seismic Reflection	18

3.2	Seismic Refraction	19
3.3	Seismic Data Acquisition	19
3.4	Seismic Detectors	20
	3.4.1 Geophone	20
	3.4.2 Hydrophone	21
3.5	Seismic Energy Sources	21
	3.5.1 Impulsive Energy Source	21
	3.5.1.1) Dynamite	22
	3.5.2 Non Impulsive Energy Source	22
	3.5.2.1) Vibroseis	22
3.6	Seismic Data Processing	23
	3.6.1 Demultiplexing	23
	3.6.2 Geometry Definitions	23
	3.6.3 Trace Editing	23
	3.6.4 Gain Compensation	24
	3.6.5 Spherical Divergence Correction	24
	3.6.6 Datum Statics Correction	24
	3.6.7 CDP Sort	24
	3.6.8 Pre-Filter	25
	3.6.9 Predictive Deconvolution	25
	3.6.10 Constant Velocity Analysis	27
	3.6.11 Early Mute	27
	3.6.12 Surgical Mute	27
	3.6.13 Surface Consistent Residual Statics	28
	3.6.14 Normal Moveout Correction (NMO)	29
	3.6.15 Surface Non-Consistent Residual Statics	29
	3.6.16 Stack	29
	3.6.17 Wave Equation Migration	30
	3.6.18 Final Filter	30
Chapter 4	<u>Seismic Data Interpretation</u>	31
4.1	Structural Interpretation	32
4.2	Base Map	32
4.3	Well Data	34
4.4	Identification of Reflectors	35
4.5	Identification of Faults	37
4.6	Time and Depth Contour Maps	37
	4.6.1 Time and Depth Contour Map of Kohat Limestone	38
	4.6.2 Time and Depth Contour Map of Lockhart Limestone	42
	4.6.3 Proposed Well Location	45
4.7	Average Velocity Graphs	45
4.8	Structural Style of Kohat and Lockhart Formation	47
4.9	Rock Properties	48
	4.9.1 Young's Modulus	49
	4.9.2 Bulk Modulus	50

4.9.3 Bulk Density	51
4.9.4 Poisson's Ratio	52
4.9.5 Shear Modulus	53
Chapter 5 <u>Discussions</u>	54
5.1 Conclusions	54
5.2 Recommendations	55
References	56

## LIST OF TABLES

Table 2.1. Stratigraphic framework of the Kohat Plateau (Modified after Meissner et al 1974)	9
Table 2.2. Generalized stratigraphic column in Nandraki / Shakardara Block (search.datapages.com)	15
Table 3.1. Pre Filter used on majority seismic lines	25
Table 3.2. Pre Filter used on 895-NSK-07	25
Table 3.3. Operator and Gap length of majority of seismic lines	26
Table 3.4. 1 Design / Application Window	26
Table 3.5. Operator length for 895-NSK-07	26
Table 3.6. Early Mute Parameters on different seismic lines	27
Table 3.7. Surgical Muting for 906-NSK-30, 906-NSK-35 and 906-NSK-36	28
Table 3.8. Final Filter applied on majority of seismic lines	30
Table 3.9. Final Filter applied on 895-NSK-07	30
Table 4.1. Different rock properties of Lockhart Formation for 906-NSK-36	48

## **LIST OF FIGURES**

Fig 1.1. Location of Study Area (Arc GIS)	2
Fig 1.2. Aerial view of area (Google Earth)	3
Fig 2.1. Tectonic map of the study area and adjoining regions (Arc GIS)	6
Fig 3.1. Seismic Reflection Geometry (modified from Robinson and Coruh, 1988)	18
Fig 3.2. Seismic Refraction Geometry (modified from Robinson and Coruh, 1988)	19
Fig 3.3. Geophone (informatik.hu-berlin.de)	20
Fig 3.4. Hydrophone (tech-faq.com)	21
Fig 3.5. Vibroseis Truck (geoexpro.com)	22
Fig 4.1. Base map of Nandraki \ Shakardara area.(LMKR)	33
Fig 4.2. Well Diagram of Kundi X1 (Courtesy DPL)	34
Fig 4.3. Interpreted Seismic section 895-NSK-07	35
Fig 4.4. Interpreted seismic line 906-NSK-35	36
Fig 4.5. Interpreted seismic line 906-NSK-36	36
Fig 4.6. Interpreted seismic line 906-NSK-30	37
Fig 4.7. Time Contour map of Top Kohat (using CorelDraw)	39
Fig 4.8. Time Contour map of Top Kohat (using Rockwork)	40
Fig 4.9. Depth Contour map of Top Kohat (using CorelDraw)	41
Fig 4.10. Time Contour map of Top Lockhart (using CorelDraw)	43
Fig 4.11. Depth Contour map of Top Lockhart (using CorelDraw)	44
Fig 4.12. Average Velocity Graph for the line 895-NSK-07	45

Fig 4.13. Average Velocity Graph for the line 906-NSK-35	46
Fig 4.14. Average Velocity Graph for the line 906-NSK-30	46
Fig 4.15. Average Velocity Graph for the line 906-NSK-36	47
Fig 4.16. Rock properties Vs Shot Points	49
Fig 4.17. Young Modulus of Lockhart Limestone	50
Fig 4.18. Bulk Modulus of Lockhart Limestone	51

## **ABSTRACT**

Nandraki / Shakardara area is one of the compressional tectonic regimes of Pakistan. In order to carry out the structural interpretation of the Nandraki / Shakardara, three seismic dip lines and one strike line were interpreted. Two way travel time and depth mapping helped in delineating the structural trend and understanding the tectonics of the area.

There are indications of reactivation of faults indicating the occurrence of various tectonic episodes. Existing structural trend of the area provides basic components of a prolific petroleum system.

Potential Reservoirs may be present with the fault planes. The main constituents of petroleum system are present but there is still a requirement of advance techniques to improve seismic resolution and quality of interpretation.



## **ACKNOWLEDGEMENTS**

We would like to gratefully acknowledge the enthusiastic supervision of Sir Yasir Zeb during this work. We thank Sir Aamir Malik for the technical discussions on the Thesis. We would also like to thank all our teachers who taught us during our stay at Bahria University Islamabad and made us able to write this report.

We are grateful to all our friends from Bahria University Islamabad for being the surrogate family during the many years we stayed here and for their continued moral support here after. From the staff, special thanks to Dr. Zafar, Sir Anwar Qadir, Sir Hummad Ghani, Sir Obaid Ur Rehman, Sir Saqib, Madam Urooj and Sir Maqsood Ali Gillani for their care and attention.

Finally, we are forever indebted to our parents for their understanding, endless patience and encouragement when it was most required.