

DEDICATION

This dissertation is dedicated to our parents, teachers and family members to whom we owe everything.

Acknowledgment

In the name of Allah, the most Beneficent, the most Merciful. All praises to Almighty Allah, the creator of universe. We bear witness that Holy Prophet Hazrat Muhammad (P.B.U.H) is the last messenger, whose life is a perfect model for the whole mankind till the Day of Judgment.

We are especially indebted to our supervisor Miss Sarah Akram for giving us an initiative to this study. Her inspiring guidance and dynamic supervision helped us to complete this work in time. Special thanks to Mr. Irfan Muhammad and Mr. Yasir Khan Jadoon for their constructive criticism and help in preparing and understanding our work.

We pay my thanks to our head of department Mr. Zafar and the whole faculty of our department especially our internal supervisor Mr. Saqib Mehmood whose valuable knowledge, assistance, cooperation and guidance enabled us to take initiative, develop and furnishing our academic carrier.

We also acknowledge the help, encouragement, endless love, support and prayers of our friends and family, who have always been sources of inspiration and guidance for us all the way.

Abstract

The main purpose of the study is to evaluate hydrocarbon potential of the well named Tolanj 01, Kohat Sub-Basin, KPK, Pakistan. This has been achieved by using complete suite of wire line logs and available well data. This complete set of data is issued by Land Mark Resources, Pakistan with the prior permission of Directorate General of Petroleum Concessions, Pakistan.

To complete the above mentioned task, all logs were correlated to mark the horizon of interest. In our case, the zone of interest was from Lockhart (Paleocene age) to Samanasuk Limestone (Late Jurassic age). After the demarcation of interested zone, each zone (i.e Lockhart Limestone, Darsamand/Kawagarh Formation, Lumshiwai Formation and Samanasuk Limestone) were evaluated in detail for the hydrocarbon potential using different sets of equations.

The methodology adopted to accomplish this task include; the measurements for the Shale volume by using Gamma Ray Log, Porosities of the Reservoir zone by Density, Neutron and Sonic Logs, Resistivity of water by using Spontaneous potential log , Saturation of water and Hydrocarbon saturation in the zones. Then mechanical properties of rocks were analyzed to understand the trends of elastic parameters in the zones, as well as to establish the relationships of elastic parameters and velocities. The relationships between the V_p , V_s , Porosity, Density, V_p/V_s and elastic parameters of interested zones helped to understand the changes in trends and reasons for these changes.

The results for the dissertation were then displayed in the form of graphs and excel sheets for the better approach towards the task.

Contents

DEDICATION	i
Acknowledgment	ii
Abstract	iii
Chapter 1	1
INTRODUCTION.....	1
1.1 Exploration History of Study Area.....	1
1.2 Objectives	2
1.3 Data Used	2
1.4 Methodology.....	2
Chapter 2.....	4
GEOLOGY.....	4
2.1 Regional Geological History of Indian Plate.....	4
2.2 Northward Drift of India.....	6
2.3 Tectonic Settings of Pakistan	6
2.4 Sedimentary Basins In Pakistan	8
2.5 Geological History of Indus Basin	8
2.5.1 Upper Indus Basin (UIB).....	10
2.5.2 Regional Stratigraphy of Upper Indus Basin.....	10
2.6 Geology Of Study Area	15
2.6.1 Kohat Plateau.....	15
2.6.2 Location of Kohat Plateau	15
2.7 Genaralized Stratigraphy of Study Area.....	17

2.8 Location Of Study Area.....	18
2.9 Petroleum System of Study Area.....	19
Chapter 3.....	21
WIRELINE LOGGING-A PRACTICAL APPROACH.....	21
3.1 Wire-line Logging	21
3.2 Generation Of Well Logs	21
3.3 Borehole Environment.....	22
3.4 Classification of Logging Tools	25
3.5 Logging Tools:	27
3.5.1 Gamma Ray and Spectral Log.....	27
3.5.2 Density Log.....	27
3.5.3 Sonic Log.....	28
3.5.4 Neutron Log.....	28
3.5.5 Caliper Log	29
3.5.6 SP Log.....	29
3.5.7 Resistivity and Conductivity Log	29
Chapter 4.....	30
PETROPHYSICAL ANALYSIS.....	30
4.1 Introduction	30
4.2 Methodology Adopted.....	31
4.2.1 Shale Volume Determination.....	31
4.2.2 Porosity Calculation.....	34
Porosity from Density Log data	34
Porosity from Sonic Log data	41
4.2.3 Resistivity of Water	44

4.2.4 Determination of Water Saturation.....	45
4.2.5 Hydrocarbon Saturation.....	48
4.3 Mechanical Properties of Rock.....	50
4.4 Elastic Parameters.....	51
4.4.1 Young's modulus.....	51
4.4.2 Shear modulus or modulus of rigidity	51
4.4.3 Bulk Modulus.....	52
4.4.4 Poisson's ratio	52
4.5 Well Logs	53
4.6 Formulas	53
4.7 Calculation of Vp.....	53
4.8 Calculation of Vs.....	54
Description of Graphs.....	54
4.9 Conclusions	65
4.10 References	66
4.11 Appendices	68
Appendix I	68
Appendix II.....	76
Appendix III.....	85

List of Graphs

Graph 4.1. Depth Vs Shale Volume For Lockhart Limestone.....	32
Graph 4.2. Depth Vs Shale Volume For Darsamand/Kawagarh Formation.....	32
Graph 4.3. Depth Vs Shale Volume For Lumshiwai Formation	33
Graph 4.4. Depth Vs Shale Volume For Samanasuk Limestone.....	33
Graph 4.5. Depth Vs Density Porosity For Lockhart Limestone.....	35
Graph 4.6. Depth Vs Density Porosity For Darsamand/Kawagarh Formation.....	35
Graph 4.7. Depth Vs Density Porosity For Lumshiwai Formation	36
Graph 4.8. Depth Vs Density Porosity For Samanasuk Formation	36
Graph 4.9. Depth Vs Average porosity For Lockhart limestone	37
Graph 4.10. Depth Vs Average Porosity For Darsamand/Kawagarh Formation	37
Graph 4.11. Depth Vs Average Porosity For Lumshiwai Formation	38
Graph 4.12. Depth Vs Average Porosity For Samanasuk Formation	38
Graph 4.13. Depth Vs Effective Porosity For Lockhart Limestone	39
Graph 4.14. Depth Vs Effective Porosity For Darsamand/Kawagarh Formation	40
Graph 4.15. Depth Vs Effective Porosity For Lumshiwai Formation	40
Graph 4.16. Depth Vs Effective Porosity For Samanasuk Formation	41
Graph 4.17. Depth Vs Sonic Porosity For Lockhart Limestone.....	42
Graph 4.18. Depth Vs Sonic Porosity For Darsamand/Kawagarh Formation.....	43
Graph 4.19. Depth Vs Sonic Porosity For Lumshiwai Formation.....	43
Graph 4.20. Depth Vs Sonic Porosity For Samanasuk Formation	44
Graph 4.21. Depth Vs Sw For Lockhart Limestone	46
Graph 4.22. Depth Vs Sw For Darsamand/Kawagarh Formation	46
Graph 4.23. Depth Vs Sw For Lumshiwai Formation	47
Graph 4.24. Depth Vs Sw For Samanasuk Formation.....	47
Graph 4.25. Depth Vs Sh For Lockhart Limestone	48
Graph 4.26. Depth Vs Sh For Darsamand/Kawagarh Formation.....	49
Graph 4.27. Depth Vs Sh For Lumshiwai Formation.....	49
Graph 4.28. Depth Vs Sh For Samanasuk Limestone	50

Graph 4.29. Showing the plot of Depth vs V_p	54
Graph 4.30. Showing the plot of Depth vs V_s	55
Graph 4.31. Showing the plot of V_p vs Density.....	55
Graph 4.32. Showing the plot of V_s vs Density.....	56
Graph 4.33. Showing the plot of Porosity vs Density.....	56
Graph 4.34. Showing the plot of Depth vs Porosity.....	57
Graph 4.35. Showing the plot of Depth vs Density.....	57
Graph 4.36. Showing the plot of V_p vs V_s	58
Graph 4.37. Showing the plot of V_s vs Porosity.....	58
Graph 4.38. Showing the plot of V_p vs Porosity.....	59
Graph 4.39. Showing the plot of Depth vs Bulk Modulus.....	59
Graph 4.40. Showing the plot of Depth vs Young Modulus.....	60
Graph 4.41. Showing the plot of Depth vs Shear Modulus.....	60
Graph 4.42. Showing the plot of Depth vs Poisson Ratio.....	61
Graph 4.43. Showing the plot of V_p vs V_p/V_s	61
Graph 4.44. Showing the plot of Average Porosity vs Bulk Modulus.....	62
Graph 4.45. Showing the plot of Average Porosity vs Young Modulus.....	62
Graph 4.46. Showing the plot of Average Porosity vs Shear Modulus.....	63
Graph 4.47. Showing the plot of Density vs Bulk Modulus.....	63
Graph 4.48. Showing the plot of Density vs Young Modulus.....	64
Graph 4.49. Showing the plot of Density vs Shear Modulus.....	64

List of Figures

Figure 1.1. Location of study area in Kohat sub-basin (Paracha et al).....	3
Figure 2.1. The Northward Drift of Indian Plate and Collision with the Eurasian Plate (Kemal and othes).	6
Figure 2.2. Tectonic sketch map showing the Himalayan collision zone and motion of India relative to Asia (in cm/year) (Jacob and Quittmeyer 1979).	8
Figure 2.3. Basin Architecture of Pakistan (OGDCL).....	9
Figure 2.4. Generalized Stratigraphy of Upper Indus Basin (Modified after Khan et al,1986) ...	14
Figure 2.5. Location and structural map of Kohat Plateau, (Ahmed et.al).....	16
Figure 2.6. Cross-section of Tolanj anticlinorium based on surface transect data, formation tops, and dipmeter data from Tolanj 1 well (after Sercombe et al., 1998).	18
Figure 3.1. Diagram showing wire-line logging in progress (“Well logging basics” by “Baker Hughes”).....	22
Figure 3.2. Borehole environment (“Well logging basics” by “Baker Hughes).....	25
Figure 4.1. Diagram showing interpretation work flow.	30

List of Tables

Table 3.1. Lithology Encountered In The Well	16
Table 4.1. Matrix densities of Common Lithologies. Constants presented here are used in the Density porosity Formula (after Schlumberger. 1972)	33
Table 5.3. Interval transit times for Different Matrices. These constants are used in the Sonic Porosity Formula. (after Schlumberger, 1979).....	421