ARTIFICIAL INTELLIGENCE APPLICATIONS FOR PORE PRESSURE AND FRACTURE PRESSURE PREDICTION FROM SEISMIC ATTRIBUTES ANALYSIS AND WELL LOGS DATA

By

Mohamed Atta Farahat Mohamed

A Thesis Submitted to the
Faculty of Engineering at Cairo University
In Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
In
Petroleum Engineering

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2018

ARTIFICIAL INTELLIGENCE APPLICATIONS FOR PORE PRESSURE AND FRACTURE PRESSURE PREDICTION FROM SEISMIC ATTRIBUTES ANALYSIS AND WELL LOGS DATA

By

Mohamed Atta Farahat Mohamed

A Thesis Submitted to the
Faculty of Engineering at Cairo University
In Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
In
Petroleum Engineering

Under the Supervision of

Prof. Dr. Abdel-Alim Hashem Elsayed

Professor of Petroleum Engineering,
Department of Mining, Petroleum and Metallurgical Engineering
Faculty of Engineering, Cairo University

Ass. Prof. Dr. Abdulaziz Mohamed Abdulaziz

Ass. Professor of Petroleum Engineering
Department of Mining, Petroleum and Metallurgical Engineering
Faculty of Engineering, Cairo University

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2018

ARTIFICIAL INTELLIGENCE APPLICATIONS FOR PORE PRESSURE AND FRACTURE PRESSURE PREDICTION FROM SEISMIC ATTRIBUTES ANALYSIS AND WELL LOGS DATA

By
Mohamed Atta Farahat Mohamed

A Thesis Submitted to the
Faculty of Engineering at Cairo University
In Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
In
Petroleum Engineering

Approved by the
Examining Committee

____
Prof. Dr. Abdel-Alim Hashem Elsayed Thesis Main Advisor
Professor of Petroleum Engineering, Cairo University

____
Ass. Prof. Dr. Abdulaziz Mohamed Abdulaziz Advisor
Assistant Professor of Petroleum Engineering, Cairo University

____
Prof. Dr. Abdel-Sattar Abdel-Hamid Dahab Internal Examiner
Professor of Petroleum Engineering, Cairo University

____
Prof. Dr. Gamal Selim Hassan Selim External Examiner
- Professor and head of Petroleum Engineering department, Minya University.

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2018

Engineer's Name: Mohamed Atta Farahat Mohamed
Date of Birth: 1 / 9 / 1992
Nationality: Egyptian
E-mail: mohamedata52@gmail.com
Phone: +2-01228355825
Address: Mit Ghmar – Dakahliyah - Egypt

Registration Date: 10 / 2014
Awarding Date: …./ 2018
Degree: Master of Science
Department: Petroleum Engineering

Supervisors:

Prof. Dr. Abdel-Alim Hashem Elsayed
Ass. Prof. Dr. Abdulaziz Mohamed Abdulzaiz

Examiners:

Prof. Dr. Gamal Selim Hassan Selim (External examiner)
Professor and Head of Petroleum Engineering, Minya University
Prof. Dr. Abdel-Sattar Abdel-Hamid Dahab (Internal examiner)
Professor of Petroleum Engineering, Cairo University
Prof. Dr. Abdel-Alim Hashem Elsayed (Thesis main advisor)
Professor of Petroleum Engineering, Cairo University
Ass. Prof. Dr. Abdulaziz Mohamed Abdulaziz (Advisor)
Assistant Professor of Petroleum Engineering, Cairo University

Title of Thesis:

Artificial Intelligence Applications for Pore Pressure and Fracture Pressure Prediction from Seismic Attributes Analysis and Well Logs Data

Keywords:

Pore Pressure, Fracture Pressure, Neural Network, Seismic Inversion, Seismic Attributes

Summary:

This study aims to investigate the pore and fracture pressure of sub-surface formations. Eaton's method is applied to predict pore and fracture pressure of wells. Inversion process with numerous algorithms are applied to seismic area of the field. Prediction methods are applied to investigate best attributes such as single, multiple seismic attribute analysis and neural network. Well logs and seismic attributes obtained from inversion process and seismic data are used to train ANN. ANN is validated using blind wells which are not included in training process. The correlations of ANN training and validation are good so ANN is applied for prediction of pore and fracture pressure for 3D seismic area of field.

Acknowledgments

My extreme appreciation goes to Allah the Almighty for giving me the provision and strength during my study. My sincere thanks go to my supervisor Prof. Dr. Abdel-Alim Hashem for his constructive criticism, patience in reading this work, valuable advice, and support throughout the period of this research, may God bless him. I also wish to express my great thanks to my supervisor Prof. Dr. Abdul-Aziz Mohamed for his support, help, guide as well as patience.

I would like to express my full appreciation to Eng. Mohamed Shehata and Eng. Ahmed Galal for assistance and guide. Special thanks to Eng. Hameeda Mahdi and Eng. Ahmed Saher for motivation and help.

More gratitude goes to my brothers, sisters and friends for enabling an environment to the success of this study and creating a conducive atmosphere in writing this thesis. Finally, I always want to appreciate the efforts of my father and my mother for their love, spiritual prayer, support and encouragement, May Allah the Almighty grant them long life (amen).

Dedication

This work is dedicated to

My father Mr. Atta and my mom, Mrs. H. Abdullah

For their love, understanding and support.

They are the reason why this is life. Love them dearly.

Table of Contents

List of Tables

List of Appendices

List of Figures

Nomenclature

ENGLISH

AI	Acoustic Impedance
ANN	Artificial Neural Networks
Pp	Pore Pressure
Ph	Hydrostatic Pressure
Po	Overburden Pressure
Vp	Compressional Velocity
OBG	Overburden Gradient
Vml	Compressional Velocity in Mud Line
Pulo	PORE PRESSURE for UNLOADING
U	Uplift Parameter
Vmax	Velocity at start of unloading
Vm	Sonic Interval velocity of shale
Vulo	Velocity of unloading
GR	Gamma Ray
GOR	Gas Oil Ratio
IGR	Index of Gamma Ray
Ip	P-impedance
MLFN	Multi-layer Feed Forward
PNN	Probabilistic Neural Network
RBF	Radial Basic Function
RC	Reflection Coefficient
SCF	Standard Cubic Foot
STB	Stock Tank Barrel
Sw	Water Saturation
TD	Total Depth
Vsh	Volume of Shale
Vp	P-wave Velocity
Ro	Observed Resistivity from log
S	Total Stress
F/D	Fracture Gradient
K	Stress Ratio
TVD	True Vertical Depth
MD	Measured Depth
Ft	Foot
ms	Millisecond
ppg	Pound per Gallon
R	Resistivity Value at Interested Depth

GREEK

σ_e	Effective Stress
σ_v	Vertical Stress
$\boldsymbol{\alpha}$	Biot Effective Stress Coefficient
σ_{max}	Effective Stress at Start of Unloading

ϕ	Porosity
$\emptyset_D$	Porosity from Density log
$\emptyset_N$	Porosity from Neutron log
μs/ft	Micro second / feet
ρ	Density
ρ_{ma}	Matrix Density
ρ_{obs}	Observed Density of Log
ρ_f	Fluid Density
Δt	Sonic Travel Time
τ	Tau Variable
μ	Poisson’s ratio