Ain Shams University
Faculty of Science
Geophysics Department

Aquifer mapping using Pre-stack Seismic Data, WDDM, Nile Delta.

A thesis submitted for the degree of Master of Science as a partial fulfillment for the requirements of Master degree of Science in Applied Geophysics.

By

Islam Yehia Ahmed Mohamed
B.Sc. in Geology and Geophysics
Faculty of Science – Ain Shams University, 2007

To

Geophysics Department
Faculty of Science
Ain Shams University

Supervised by

Prof. Dr. Abd Elnaser Mohamed Helal

Professor of Geophysics
Geophysics department – Faculty of Science – Ain Shams University

Dr. Azza Mahmoud Abd El-Latif El-Rawy

Lecturer of Geophysics
Geophysics department – Faculty of Science – Ain Shams University

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Note

The present thesis is submitted to faculty of Science, Ain Shams University in partial fulfillment for the requirements of the Master degree of Science in Geophysics.

Beside the research work materialized in this thesis, the candidate has attended ten post-graduate courses for one year in the following topics:

1. Geophysical field measurements
2. Numerical analysis and computer programming
3. Elastic wave theory
4. Seismic data acquisition
5. Seismic data processing
6. Seismic data interpretation
7. Seismology
8. Engineering seismology
9. Deep seismic sounding
10. Structure of the earth

He successfully passed the final examinations in these course.

In fulfillment of the language requirement of the degree, he also passed the final examination of a course in the English language.

Prof. D. Said Abdel-Maaboud Aly

Head of Geophysics Department

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Dedication

This work is dedicated to my **family** who has been always supporting me. Especial dedication is to my **mother** whose love and devotion kept me going.

Abstract

Water production is the main production problem in WDDM concession in Nile delta. Water comes in surprisingly so fast with high rates. This comes from the underestimation of the aquifer description. Usually aquifer is estimated "guessed" and modeled as numerical aquifer. Unfortunately stacked seismic reflection data doesn't help so much in mapping aquifers. Water sands reflectivities appear as much dimmer amplitudes. If seismic can give a hand in this it would be priceless knowledge. The study area, Sequoia gas field, is located in West Delta Deep Marine (WDDM) concession. It is about 70 kilometers to the North East offshore Alexandria.

The rock physics model suggests that, the intercept and the gradient of a shale-to-shale interface are close to those of shale-to-water interface. However the shale-to-gas interface has about the same magnitude (but opposite polarity) of shale-to-water however the gradient is much higher. So when the seismic CDPs are stacked, gas sand amplitudes dominates the picture and the water sands lie in the same color range of the shales. In order to overcome this problem, we need to go back to the pre-stack data and invert them for the physical properties, so their effect on the post-stack can be separated, analyzed and used for the seismic facies classification.

AVO simultaneous inversion inverts pre-stack seismic into elastic properties; compressional impedance, shear impedance and density. The products of AVO simultaneous inversion can be coupled with other wire-line logging data via Bayesian classification, so seismic sections can be transformed into geologic cross-sections with meaningful facies codes. Then water sands can be discriminated from other facies existing in the field so they can be delineated, mapped and modeled in the 3D static models. The Bayesian classification outputs gave a reasonable match to the actual facies found in the wells of the study area.

Keywords: Water production, AVO simultaneous inversion and Naïve Bayesian Classification

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