AIN SHAMS UNIVERSITY
FACULTY OF SCIENCE
GEOPHYSICS DEPARTMENT

Seismic De- Multiple Techniques, Studies and Optimization

BY
KHOLOUD BADR ELIOW
B. Sc.

A THESIS
SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE MASTER DEGREE OF SCIENCE

IN
GEOPHYSICS
Supervised by

PROF. DR. A. NASSER HELAL
Professor of Geophysics
Geophysics Department
Faculty of Science
Ain Shams University

DR. AHMED ELBASSIONY
Associate Professor of Geophysics
Geophysics Department
Faculty of Science
Ain Shams University

CAIRO, EGYPT.
2015

ACKNOWLEDGMENTS

First and above all, I would like to express my great thanks to" ALLA" who supplied me with strength and patience to complete this work.

I am indebted to express my deepest gratitude and appreciation to Prof. Dr. A. Nasser Helal Professor of Geophysics and Dr. Ahmed Elbassiony Associate Professor of Geophysics, Department of Geophysics, and Faculty of science, Ain Shams University, Cairo, Egypt, for supervising, critical reading and revising the manuscript.

My deep thanks, gratitude and appreciation are extended to Dr. Ahmed Elbassiony Associate professor of Geophysics, Geophysics Department, Faculty of Science, Ain Shams University, for suggesting the point of research, supervising and planning the work, critical reading and revising the manuscript.

My deep thanks Petroleum Geo-Services for facilitating the software for processing the 2D synthetic dataset.

ABSTRACT

The development of the surface related multiple elimination techniques have started to take a new curve. The traditional techniques using velocity discrimination of multiples and periodicity estimation are on their final development peek. The reason these techniques have reached a stall development is due to the problems they failed to solve in complex water bottom structures. This work will show how a 2D synthetic data with fairly complex water bottom relief can have quite complex interference of primaries and multiples in the near-surface without being correctly predicted by these techniques. The 2D SRME technique will have some problems in 2D in predicting the multiples at their correct time and phase.

The predictive deconvolution can still be accounted for in the shallow water bottom situation given the water bottom is flat. The limitation that will be presented in this work will through the light on the need of a more powerful technique that is free from assumptions related to the natural geologic nature of the problem. Instead, the optimal technique shall use the details of the geologic nature of the problem to solve it. The conclusion is to highlight the advantages and disadvantages of each of the studied methods so that precautions can be taken into account when dealing with similar geologic situations, and to draw a best practice for at least two different degrees of complexity of the water bottom

Contents

List of Figures

List of Tables

Chapter One
Introduction

1.1 General Outline

The basic models in seismic processing assume that reflection data only consist of primaries (Hill, S., Dragoset, B., and Weglein, A., 1999). So far, multiples are considered as noise in seismic data. We have to suppress these multiples prior to migration, inversion, AVO analysis, and stratigraphic interpretation. Otherwise, multiples can be misinterpreted as, or interfere with, primaries and dramatically change the results of migration, inversion, AVO analysis, and stratigraphic interpretation.

According to where the downward reflection of the ray path occurs, multiples can be divided into two types (Dragoset, 1999); One is free-surface multiples that are sometimes referred to as surface-related multiples or surface multiples. This type of multiple has at least one downward reflection at the air-water "free surface" simple water-bottom multiples (or pure water-bottom multiples) and second-order water- bottom multiples (or seafloor peg-leg) or reverberation belong to this type of multiples.

The other type is internal multiples that have all of their downward reflections below the free surface. This type of multiple gets more attention when the exploration target is a subsalt or sub-basalt layer.

Over the years, many techniques for suppressing multiples have been tried. In recent years, multiple-suppression techniques based on the wave equation have attracted attention because they seem to suppress all multiples without coincidentally attenuating the primaries (Dragoset, 1998). The choice of multiple-suppression methods does not only depend on the effectiveness of each method but is a compromise of the effectiveness, processing objective and cost of each method. Each method has its own assumptions, and it is useful when these assumptions are compatible with the data.

Three basic methods for suppressing multiples exist in published literature. The first group of methods, Deconvolution methods that use the periodicity of multiples for suppression and are effective in suppressing short-period free-surface multiples generated at shallow reflectors.

The second group of methods, surface related multiple elimination (SRME) and adaptive subtraction use recorded data to predict multiples this method obtain multiple-free data by subtracting the predicted multiples.

The third group of methods, filtering methods that use differential move-out between primaries and multiples that are separate in Radon domains. These filtering methods can successfully suppress multiples generated at moderate to deep reflectors where multiples are well-separated from their primaries.

In order to effectively attenuate residual multiples two strategies were applied:

Strategy 1: models for the SWD (deterministic de-convolution), Tau-P predictive deconvolution (statistical de-convolution) and surface related multiple elimination (SRME) were created from the input data then a multi adaptive subtraction was performed for all of them.