Common Focus Point Technology

Proefschrift

ter verkrijging van de graad van doctor
aan de Technische Universiteit Delft,
op gezag van de Rector Magnificus,
Prof. dr. ir. J. Blaauwendraad
in het openbaar te verdedigen
ten overstaan van een commissie,
door het College van Dekanen aangewezen,
op dinsdag 21 januari 1997 te 10:30 uur

door

Jan Willem THORBECKE

mijnbouwkundig ingenieur

geboren te Oostzaan

Dit proefschrift is goedgekeurd door de promotor:

Prof. dr. ir. A. J. Berkhout

Samenstelling promotiecommissie:

Rector Magnificus, voorzitter
Prof. dr. ir. A. J. Berkhout, (*TU-Delft, Technische Natuurkunde*), promotor
Prof. dr. ir. J. T. Fokkema, (*TU-Delft, Technische Aardwetenschappen*)
Prof. dr. ir. P. M. van den Berg, (*TU-Delft, Electrotechniek*)
Prof. dr. ir. I. T. Young, (*TU-Delft, Technische Natuurkunde*)
Prof. dr. J. C. Mondt, (*U-Utrecht, Aardwetenschappen*)
Dr. ir. C. P. A. Wapenaar, (*TU-Delft, Technische Natuurkunde*)
Dr. ir. W. E. A. Rietveld, (*Amoco, Exploration and Production Technology Group*)

ISBN 90-9010-123-3

SUPPORT
The research for this thesis has been financially supported by the DELPHI consortium.

Typesetting system: LaTeX2e
Cover: 'combined snapshots from one point source'
Printed in The Netherlands by: Beeld en Grafisch Centrum Technische Universiteit Delft.

'Alles komt voort uit de chaos', wordt er in de Griekse Anthologie gezegd. En inderdaad, alles komt voort uit de chaos. Buiten de wiskunde, die enkel met dode getallen en loze formules te maken heeft en derhalve volmaakt logisch kan zijn, is de wetenschap niet meer dan een kinderspel in de schemering, het willen vangen van vogelschaduwen en het willen tegenhouden van de schaduw van gras dat waait in de wind. (290 [479], Pessoa (1990))

Preface

In January 1991 I finished my MSc project, which was supervised by professor Fokkema and professor Van Den Berg, at the department of applied Earth Sciences. During the MSc project professor Fokkema showed me the good things of seismic research. At the end of the academic year, August 1991, professor Fokkema introduced me to the group of professor Berkhout where I could begin a PhD study within the DELPHI project. Research in the Geophysical context was something I started to like a lot and working in a team was also an important reason for starting my PhD project in the group of professor Berkhout. The subject of my PhD project was initially set up to investigate the combination of elastic wavefield decomposition and weathered layer influences. In the first year it became clear that correct estimation of the propagation properties of the weathered layer is very important for the decomposition and all the further processing steps. Therefore the subject of my research changed to weathered layer estimation, using the areal shot record technology. An important side-off project of these first years was an optimization technique I used to construct the decomposition operators. This technique is also very successful for the optimization of extrapolation operators. During my work with areal shot records the areal shot record designed for one point in the subsurface turned out to be a very useful intermediate step for imaging and velocity analysis. So finally the subject changed for the last time to Common Focus Point technology the main subject of this thesis. The last 2 years I have been working intensively on this subject and the results can be found back in this thesis. Note that although it seems that I have been doing a lot of other things besides the main subject of this thesis, all the things I have done before helped me to understand the main geophysical problems and gave me a broad overview.

During the past 5 years I have learned a lot from professor Berkhout, Kees Wapenaar and Eric Verschuur, who are the driving forces behind the DELPHI research team. The discussions I have had with my fellow PhD students were always stimulating and very useful for understanding the practical implications of the theory. The DELPHI consortium, which is sponsored by the oil and computer industry, reports twice a year the research results at the so called sponsor-meetings. Once a year a book,

with the latest scientific results, is published for the sponsors. At first I found it difficult to give oral presentations at the sponsor meetings, but during the years I have learned how to give a presentation and in the last year I hope the sponsors could follow what I was saying. At this point I wish to thank the participating companies for making the research within DELPHI possible, and for their interest and comments they gave at the sponsor meetings.

There are many people who have helped me in the last 5 years. First of all I would like to thank my promoter, professor Berkhout, for supervising this thesis, his enthusiasm about the subject and his stimulating ideas. The comments and suggestions Kees Wapenaar gave me during the years, especially for the theoretical part of this thesis, have been very useful and gave the theoretic parts its clear structure. Eric Verschuur always knew the answers to all my questions, and independent of the subject the answer was always useful.

Beside all the new knowledge about geophysics I've also learned how to work in a team. My colleagues of the first year Greg, Cees and Erwin helped me starting my research. Walter learned me everything, I always wanted to know, about areal shot record technology and showed me how to make up reasons for not running during lunch-time. I also would like to thank Aart-Jan, Frederic and all the incidental 'runners' for running with me during lunch-time. I'm thankful for the patience of Nurul, and all the other students who have worked with my programs, with the build in features/bugs of my programs. During the years Riaz became a very good friend and we have had a lot of good times together. The boys of next door Felix, Frank and Wim are remembered for being very quiet neighbors. I will miss Felix for letting me know the latest news on the wave-equation, and Frank for providing the running group with sun-milk during the run.

Without the system management of JWdB, Leen, Edo and Henry a lot of work couldn't be done at all. JWdB and Felix introduced NEXTSTEP into the group, which resulted in an important improvement in the development of applications and state of the art pictures. Although Alexander is not a part of the system management I will never forget his famous Unix scripts and his willingness to help to get the system up again, after a serious crash. I also would like to thank Bart and Scott of Cray Research in Eagan for offering me a great job at Cray Research / Silicon Graphics. I wish the new PhD students the same good time I have had in the DELPHI team, specially the never ending good weeks during the sponsor meetings and geophysical congresses.

The last months, while I was writing this thesis, my family and Roos kept me on the right track and helped me remembering that there are more things to life than writing a thesis.

Contents