MIGRATION-VELOCITY ANALYSIS USING IMAGE-SPACE GENERALIZED WAVEFIELDS

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FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

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I certify that I have read this dissertation and that, in my opinion, it is fully adequate in scope and quality as a dissertation for the degree of Doctor of Philosophy.

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Abstract

An accurate depth-velocity model is the key for obtaining good quality and reliable depth images in areas of complex geology. In such areas, velocity-model definition should use methods that describe the complexity of wavefield propagation, such as focusing and defocusing, multiple arrivals, and frequency-dependent velocity sensitivity. Wave-equation tomography in the image space has the ability to handle these issues because it uses wavefields as carriers of information. However, its high cost and low flexibility for parametrizing the model space has prevented its routine industrial use.

This thesis aims at overcoming those limitations by using new wavefields as carriers of information: the image-space generalized wavefields. These wavefields are synthesized by using a pre-stack generalization of the exploding-reflector model. Cost of wave-equation tomography in the image space is decreased because only a small number of image-space generalized wavefields are necessary to accurately describe the kinematics of velocity errors and because these wavefields can be easily used in a target-oriented way. Flexibility is naturally incorporated into wave-equation tomography in the image space by using these wavefields because their modeling have as the initial conditions some key selected reflectors, allowing a layer-based parametrization of the model space.

To use the image-space generalized wavefields in wave-equation tomography in the image space, the method is extended from the shot-profile domain to the image-space generalized-sources domain. In this new domain, the velocity updates are very fast. Migration with the optimized velocity model provides good quality and reliable depth

images, as can be seen in a 3D-field data example.

Preface

The electronic version of this report[1] makes the included programs and applications available to the reader. The markings **ER**, **CR**, and **NR** are promises by the author about the reproducibility of each figure result. Reproducibility is a way of organizing computational research that allows both the author and the reader of a publication to verify the reported results. Reproducibility facilitates the transfer of knowledge within SEP and between SEP and its sponsors.

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[1] http://sepwww.stanford.edu/private/docs/sep141
[2] http://sepwww.stanford.edu/public/docs/sepdatalib/toc_html

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Our testing is currently limited to LINUX 2.6 (using the Intel Fortran90 compiler) and the SEPlib-6.4.6 distribution, but the code should be portable to other architectures. Reader's suggestions are welcome. For more information on reproducing SEP's electronic documents, please visit *http://sepwww.stanford.edu/research/redoc/*.

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