Seismic Imaging and Inversion: Application of Direct Nonlinear Inverse Theory

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Preface

In the first volume of this two-volume set "Seismic Imaging and Inversion: Applications of Linear Theory" there is a systematic development and advancement of methods for locating (imaging, migration) and identifying (inversion, migration-inversion) targets that assume that an adequate velocity model of the medium between the measurement surface and the target is known. That assumption leads to a linear relationship between recorded reflection data and the spatial determination of reflectors. It also assumes that all multiply reflected events have been removed before the migration and migration-inversion. In addition, linearity assumes a linear relationship between the imaging result and the changes in mechanical properties at the target (migration-inversion).

In the second volume, "Seismic Imaging and Inversion: Applications of Direct Non-linear Inversion Theory", all the requirements and assumptions within a linear theory are relaxed and removed. The text follows, chapter by Chapter, the steps that recorded reflection data takes from the time it's recorded, followed by the reference wave predicated and removed, source and receiver ghosts removed, free surface and internal multiples removed, non-linear direct target identification, and compensation for absorption without knowing, estimating, or determining the absorptive mechanism. All these tasks are achieved directly without knowing, estimating, or determining subsurface properties — and without assuming any linear approximate relationship in any step in the processing chain. The final chapter, Chapter 14 examines and clarifies the meaning of a linear relationship. The conclusion is that a linear relationship must be linear in a recorded data that is adequate to solve the problem directly and non-linearly. That provides a full circle for this two-volume set, since the data required for a direct non-linear solution is defined and examined in Chapter 12. All the direct non-linear imaging and inversion methods of Volume II reduce to the direct linear imaging and

inversion methods of Volume I when the assumptions behind linearity are satisfied.

The linear methods of Volume I are within current conventional concepts and application. The direct non-linear imaging and inversion methods of Volume II supersede their linear counterparts and represent a fundamentally new and more effective capability, that will continue to be developed and will change and improve seismic exploration. There are other fields of non-destructive evaluation, like medical imaging and buried target (tunnel) detection that can benefit from these advances in seismic data processing and analysis.