Chapter 6

Conclusions

A method of determining interval velocities through tomographic inversion has been proposed and tested in this thesis. The inversion process uses seismic data that has been picked by the method of Controlled Directional Reception (CDR).

The CDR method provides an automated way to pick important parameters of the major events in reflection seismic records. When only the major events are picked, the volume of the data is tremendously reduced. Each pick is independent of all the others, so there is no need to make assumptions about horizon continuity, and events from weak, discontinuous, intermediate horizons can be picked as well as events from strong horizons. The picked parameters contain enough information for an interval-velocity analysis to be performed.

The velocity is analyzed by tracing rays through a model, and determining which changes in the model would result in a better correspondence between the model and the data. In this thesis a gridded velocity model was used, which resulted in a successful algorithm, but one that consumed a great deal of computer time. Common sense would suggest that an inversion based on picked parameters and on ray tracing should be considerably cheaper than one based on the full data set and on the wave equation. The results of this thesis do not fully uphold that common-sense conclusion, but there exists the possibility that a more carefully constructed model and algorithm would lead to a less time-consuming procedure.

The following sections summarize the work performed in this thesis, and list some conclusions that can be drawn as a result.

6.1 Summary

1). The method of Controlled Directional Reception was successfully used to pick significant events from a marine data set (Figures 2.10 and 2.11, page 32).

2). The picked parameters were used directly, without any interpreter-aided velocity analysis, to produce a time-migrated section (Figure 2.7, page 29).

3). The picked parameters were filtered on the basis of velocity, amplitude, and dip, to remove multiples and noise (Figure 2.12, page 33).

4). An objective function was proposed to determine the fit between the picked parameters and a trial velocity model (Figure 3.3, page 41).

5). Filtered picked parameters were used to produce an interval-velocity model, by minimization of the objective function. The procedure was tested on synthetic data (Figure 3.9, page 51), as well as on field data (Figure 4.1, page 58).

6.2 Interpretation and conclusions

1). The CDR method is successful at picking events from reflection seismic data.

2). Time-migrated sections, based on CDR velocity, provide useful preliminary information for the interpreter. Stereo time-migrated sections (Figure 2.8, page 30) display additional information.

3). Most water-bottom multiples are eliminated through CDR velocity filtering. Near-offset multiples, however, are not always eliminated, because small errors in the picked parameters can change the apparent CDR velocity of the multiples.

4). The x_{err} objective function is stable and economical.

5). It is not difficult to devise ray-tracing and optimization schemes for gridded media. There is a price, however: such a scheme requires more grid parameters than data parameters, and the necessary damping terms lead to an ill-conditioned inversion. It may be better to use smooth basis functions.

6). The inversion scheme works on field data. A large amount of damping is necessary, however, to prevent instability in the ray tracing. As a result, only low-frequency components of the velocity field can be determined.