Preliminary case studies on synthetic and real data confirm the utility of soft inversion techniques; results presented in the paper will include a comparison of the performance of these techniques vis-a-vis traditional 1D inversion techniques, and where possible, other statistical techniques such as Bayesian inversion and stochastic inversion. The paper will include general guidelines for the effective application of soft inversion techniques, based on the experience gained in these case studies. Finally, an example will be presented of the use of soft estimates for porosity (inferred from seismic data) to augment sparse well information in the characterization of the spatial variability of porosity in a dolomite reservoir.

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ONE-PASS INVERSION OF MARINE SEISMIC DATA (C-7)

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We propose an acoustic inversion scheme for marine seismic data consisting of three stages: (1) preprocessing, (2) inversion, and (3) amplitude-versus-angle analysis. Stage 1 consists of

(a) signature deconvolution, in which we take into account the source directivity,
(b) transformation of the $\omega-P$ domain,
(c) calibration for system sensitivity using the critical reflection theorem, and
(d) removal of the free surface effects.

In stage 2 we determine true-valued primary reflection coefficients with an efficient stabilized inversion algorithm. This algorithm is the inverse of the reflectivity method and, using the principle of causality, consists of a layer-stripping procedure recursively applied in the pre-critical part of the $\omega-P$ domain. The series of internal multiples related to the stripped layer is subtracted from the signal.

In stage 3 we analyse the primary reflection coefficients from stage 2 using conventional AVO methods. The variation with $p$ of the amplitude of the reflection coefficient of one interface serves as a lithology indicator. In practice we can estimate the first-order gradient of this variation, and the average amplitude of the reflection coefficient by elliptical moveout correction (EMO) — similar to NMO in the $x-T$ domain — and stacking.
INVERSION 1

The final results we obtain are (1) a zero offset section of primary reflection coefficients and (2) a gradient section.

We present results of the processing with our method of the data from the Delft airgun experiment: a marine seismic line shot over a logged well. The gradient section is compared with a synthetic section calculated from the well log data. The sensitivity of the scheme to the correct processing parameters will be demonstrated by showing the final results when (a) the source directivity is neglected and (b) the source wavelet is determined using conventional predictive deconvolution. This research was partly sponsored by the EEC under contract no. TH.01.39/84.

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SEISMIC INVERSION BY AN INTEGRAL EQUATION METHOD
(C-8)

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The inversion method presented here is based on the well-known idea of interpreting the spatially-varying propagation speed as a perturbation of a constant reference velocity. Applying the Green’s function method to the wave equation, a 1st kind Fredholm integral equation for the perturbation potential is derived. To treat the ill-posedness of this problem, it is necessary to apply regularization methods such as truncated singular value decomposition or Tikhonov regularization.

Some numerical results for Born inversion applied to 1D synthetic data are presented. Also, an iterative approach, based on the combination of the integral equation inversion with an appropriate calculation of the Green’s function, is discussed.

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