INVERSION

INVERSION OF REAL SEISMIC DATA – PHILOSOPHY (C-25)

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For a monopole source and a point receiver, every seismogram can be modelled as the scaled convolution of a source wavelet with a Green’s function, plus noise. The task of signature deconvolution is to remove the wavelet from the seismograms. The task of inversion is to recover the elastic parameters of the earth from the Green’s functions. Whether these tasks are done scientifically or not depends on whether the theories on which they are based are in principle refutable, according to Popper’s demarcation criterion. Any theory of inversion of seismic data should in principle therefore be refutable by well log or VSP data. Equally, the corresponding theory for the forward modelling of synthetic seismograms from well logs should in principle be refutable by seismic data or VSP data.

In general neither the source nor the receiver can be considered as points. The deconvolution must therefore take into account the directivity patterns of both. This can be done approximately in the frequency–wavenumber domain on common midpoint gathers. The source wavefield is determined from near-field measurements and the notional source concept.

To perform inversion on real data, the numbers on tape must be converted to absolute values of the measured variable (pressure for marine data, or particle velocity for land data). Normally the calibration factors are not known and difficult to measure, so this calibration is difficult. We use the post-critically reflected data to estimate the calibration factor from the free surface multiple behaviour, knowing from the critical reflection theorem that the amplitude spectrum of the plane wave reflection response, without free surface effects, is equal to unity for all frequencies.

We invert the data with a layer-stripping approach, building the model from the top downwards. At this point we use only an acoustic horizontally-layered model of the earth. We put our inversion theory at risk using seismic data from the Delft Air Gun Experiment, and comparing the inversion results with the well log data.

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