Source Estimation from Pre-Stack Seismic Data using Nonlinear Bounded Minimization Technique

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Abstract

Source signature estimation is an important problem in seismic data processing and inversion. Inaccurate estimation of the source function leads to incorrect estimates of Earth parameters. In exploration seismics, one common approach is to estimate the source independently of the Earth parameters. These processing-oriented techniques usually make assumptions about wavelet phase and/or the statistics of reflectivity. In this paper we utilize differential (non-parallel) moveout over offset in prestack gathers to estimate the source function (Minkoff et. al, 1997). Our choice of prior information favors oscillatory wavelets and spiky reflectivity traces when input data constraints are weak. The inversion operates on input data having no moveout correction. Therefore wavelet stretch related to moveout correction, which typically degrades bandwidth and resolution, is not an issue. We propose a nonlinear inversion method that minimizes a mixed-norm objective function subject to fitting the L2 norm of the data. A full-Newton interior point method accommodates our bounds on reflectivity and the mixed norms on model parameters. Field data and synthetic data examples illustrate that the inversion methodology effectively deconvolves the source contribution, and at the same

time estimates reflectivity with high resolution. We jointly recover mixed-phase wavelets and AVA parameters to within a scale factor. Moreover, the inverted intercept and gradient traces estimated along with wavelets exhibit much greater time resolution than, say, stacked data. We attribute this resolution in part to the inherent designature of the inversion.