P172 RECOVERY OF LOW AND HIGH FREQUENCIES IN VSP RECORDS BY ANALYTICAL CONTINUATION OF SPECTRA

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The prospects of evaluation of geological section from VSP records as well as from surface seismic records are sufficiently restricted by narrow frequency band.

Very low near zero frequencies do not pass the acquisition system. High frequencies are severely attenuated while propagating through absorptive media. Besides these frequencies are generated in a source with a small weight respectively to dominant frequencies.

That is why low near-zero frequencies are not present in the records and high frequencies are masked by noises. Then we can not evaluate absolute values of acoustic impedances after inversion and can not resolve layers with the thickness of meters units.

There are at least two strong motivations to develop special procedures for extrapolation spectra of VSP records.

The first follows from one of the most important applications of VSP - to be close to well logging in resolution and provide the extrapolation of high resolution image in the vicinity of the well (Galperin, 1994)

The second motivation is due to the favourable conditions for inversion of VSP data.

- The full wave form of signal is available from downgoing waves.
- High signal to noise ration is due to absence of surface waves.
- High frequencies are not absorbed by weathering layer.
- Spectrum of VSP trace is close to analytic function, because in time domain the trace is limited from the left by the first break point and quickly attenuates to the right.
- Strong apriori limitations may be available from model produced from log data in the well.

Basing on this advantages the iterative algorithm (Bakushinsky and Goncharsky, 1989) was used to estimate ideal pulse seismogram $g(t)$ with full spectrum:

$$g_{n+1}(t)=\frac{1}{1+c_n}P_G\left[g_n(t)-dB^*BA^*\left(Ag_n(t)-u(t)\right)\right],$$

where

$g_n(t)$-estimate of pulse seismogram for "n" step;

P_G-operator, projecting to set of possible solutions G;

B-linear integral convolution operator;

A-signal waveform;

u(t)-original seismogram;

c_n, d-parameters of iteration procedure.

Normal incidence seismograms were computed for specified model.

The iterative algorithm was applied to original modelled traces with frequency band 8-120 Hz.

Low frequencies up to zero high and frequencies up to half Nyquist were reconstructed with high accuracy for noise free data.

After addition of up to 5% of white noise to original seismogram the quality of recovery worsens.

Nevertheless the recovered frequency band is sufficiently wider and noise amplification is much less then for optimal deconvolution.

The use of reasonable apriori information makes procedure more stable.

The procedure developed may help to restore low frequencies for estimating absolute values of acoustic impedances and increase high frequency content of VSP seismograms for better resolution.

The set of real VSP data obtained with six-point downhole geophone string above the level of 2740m. was used to predict acoustic impedances for lower interval up to 3140m.

The usual processing chain included predictive deconvolution, wave separation, optimal spike deconvolution for each of ten shots (60 levels). Deconvolved downgoing and upgoing waves for all levels were stacked to improve signal to noise ratio. Stacked data were additionally deconvolved to provide plane spectrum of downgoing wave in 8-250Hz frequency band.

The analytical continuation of spectrum was made only for six levels from one shot after spike deconvolution.

The inversions of traditional and analytically continued results were compared to each other and to acoustic impedances from log data in 2740-3140m. interval.

Better resolution and more realistic low frequency content for analytically continued data approved the possible applications of developed procedure.

References:

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