Analysis of a broadband processing technology applicable to conventional streamer data

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Summary

We recorded 2D lines parallel to and in close proximity of one another, with streamers towed at different depths. We applied WiBand, GXT’s broadband processing method, to a deep tow line and recovered data free of receiver ghost notches. We find a good phase match between the WiBand result and a shallow tow line. The match validates the phase fidelity of the WiBand process.

Introduction

Over the past few years, different techniques have emerged that makes it possible to mitigate or remove the effects of the ghosts and obtain broadband images with greatly enhanced resolution. However, the methods, including over-and-under streamers, GeoStreamer, and BroadSeis, require new data acquisition. They are not applicable to conventional streamer data acquired with hydrophone-only streamer cables tow at a constant depth for each survey.

We have developed an effective broadband processing method that can remove most of the ghost effects from conventional streamer data. In this abstract we will refer to this method simply as WiBand for convenience. (WiBand is a trademark of GX Technology.) This method is designed to address both the amplitude attenuation and the phase distortion introduced by the ghosts to obtain nearly flat spectral response from 4Hz to 150Hz, as well as a compact, well focused seismic wavelet. In order to validate our method, we carried out an experiment where multiple streamers were towed at different depths, and evaluated the phase reconstruction fidelity of the algorithm by comparing the WiBand result from the deep tow data with the standard processing result from the shallow tow data.

Analysis of WiBand Results

We acquired data with a number of source and streamer depth combinations over the same general line location. For this paper we focus on the data associated with the 5m source and the streamers at 12m and 7m depths. We will refer to the data from these two streamers as the deep tow line and the shallow tow line respectively.

Figure 1 Left: Deep tow data high-cut filtered beyond receiver ghost notch. Right: WiBand result.

In the left panel of Figure 1, we show the deep tow data after a standard high-cut filter. In the right panel, we display the WiBand result from the same line. The respective spectra are plotted in Figure 2, left panel. As evident both from the spectrum plots and from the stack displays, the WiBand result contains broadband information. WiBand has recovered the previously much attenuated signal around 62Hz and 123Hz and filled in the notches. The low frequencies have also been considerably enhanced. However, we need to validate the phase fidelity of the recovered signal. For this purpose, we use the shallow tow data as the standard against which we compare the phase response of this WiBand result.
We apply a zero phase high cut filter to the shallow tow data to remove signal above its receiver notch, which is at ~110Hz. The result is displayed in Figure 3, left panel. We then apply a different zero phase trapezoidal filter to the deep tow data WiBand result to shape its spectrum to be broadly similar to that of the high cut filtered shallow tow data. The resultant image is displayed in Figure 3, right panel. The corresponding spectra are plotted in Figure 2, right panel. Note that the deep tow notch frequency of 62Hz is close to the dominant frequency of these two filtered results.

By comparing two images above, we determine that the two results match well in phase. We plot two traces, one from each line, in Figure 4, left panel. These traces are from the same CDP location, chosen arbitrarily. The traces have the afore-mentioned filters applied. The phases of the main events match remarkably well. Because the recovered signal around 62Hz contributes strongly to the wiggle plot of the shape-filtered WiBand trace here, such a match cannot be obtained unless the phase of the recovered signal has been reconstructed correctly. The right panel shows a similar comparison.

Conclusions

We have successfully obtained broadband signal from deep tow streamer data. The prominent receiver ghost notch at 62Hz is filled. An essentially flat power spectrum is recovered between 4Hz and 150Hz. We have validated the result by comparing it to shallow tow data, which is known to have a near-zero-phase wavelet below 110Hz. The comparison indicates that the phase of the recovered broadband data matches that of the shallow tow data.

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