Removal of High Amplitude Noise and Preservation of Relative Amplitudes – A Case Study.

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Summary

The presence of high amplitude noise corrupts the dataset in each subsequent stage of data processing, which may lead the less reliable end product of processed seismic data. To overcome this problem, normal de-selection methods were used by taking reference to the average absolute amplitudes over different windows of analysis thus removing the high amplitude noise bursts and noisy/dead traces. This resulted in preservation of relative amplitudes which are otherwise generally disturbed by auto editing methods and also in increased signal to noise ratio thus improving the reliability of the entire data set. This present method is found to be superior as it saves time for the processor from manual editing and simultaneously avoids using statistically controlled auto editing method that fails to preserve the relative amplitude.

Introduction

Clean pre-stack data with improved signal to noise ratio is needed for processes such as velocity determination, prestack migration and AVO/AVA studies. In order to achieve this, it has to be ensured that high amplitude noise and other cultural noise that are unavoidable during land data recording are identified and removed during the initial stage of processing itself. High amplitude noise is a special problem when least square methods are used at later stages of processing, since the square of a high amplitude error is likely to overpower the smaller errors that are of more interest. (Ray Abma et al, 1996).

Therefore, a method was tested successfully to identify and eliminate the high amplitude as well as cultural noise by simple de-selection with reference to the average absolute amplitudes that are encountered consistently over different windows of analysis for individual traces. Care was taken to avoid accidental removal of good traces in this process. Since the common theme of several papers or references in the AVO literature aims at retaining the relative amplitudes of primary reflections, care was taken to preserve the same rather than the true amplitudes (Ostrander, 1984). This was ensured by checking the amplitude curves at each stage of processing with respect to offsets to retain the same behavior.

Removal of cultural and high amplitude noise

A dead trace is not actually dead unless it is located and scaled down to zero. Otherwise it may mix up as an active trace with other traces causing problems to the processor in subsequent processing. Finding out a dead trace in a raw shot record is made easier with the selection of average absolute amplitudes to be zero consistently over different windows of analysis.

To isolate and remove traces with cultural and high amplitude noise, the ranges of absolute average amplitudes were determined over different windows to each trace thus discriminating from normal traces. Selection of the window and the threshold values determine the quality of the output.

Field data example

Representative shot gathers pertaining to 3-D land data were chosen for effective removal of high amplitude noise bursts and cultural noise dominant in the data. The average amplitudes were plotted at selected offset ranges to keep control on preserving the relative amplitudes.

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Figs-1 & 2 show three raw shot gathers which were considered for study with two different time windows of analysis. No process has been applied on this data except for display scaling. On top of the gathers, shown are the average absolute amplitudes over a selected time window of analysis whose highs coincide with the high amplitude noise present in the corresponding individual trace. Thus, noisy traces are clearly seen discriminated.

Fig-3 shows the same set of raw shot gathers after removal of cultural and high amplitude noise. Depending

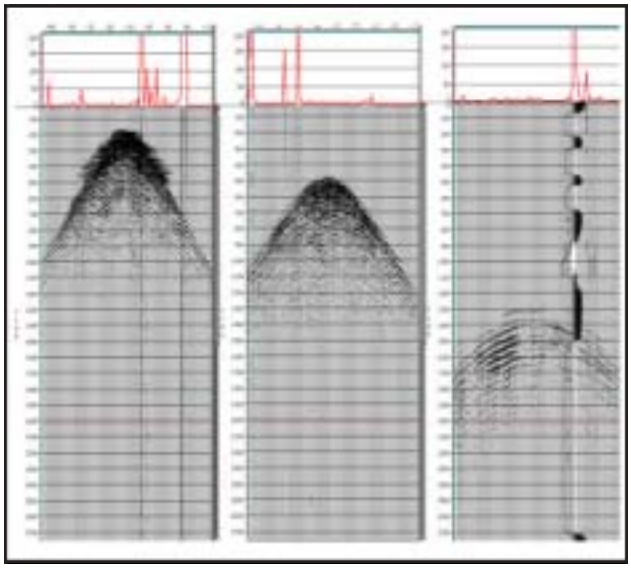

Fig-1: Three raw shot gathers with normal display setting with top panel showing the absolute amplitudes over a time window for each individual traces.

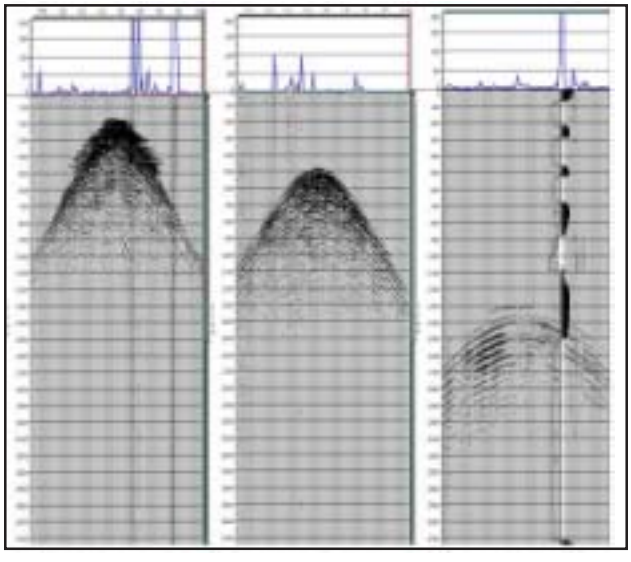

Fig-2: Same shot gathers shown above with top panel showing the absolute amplitudes over another time window of analysis.

upon the highs, the traces are deselected for further processing. Consistency of the de-selection was verified by defining concurrently different windows for analysis to avoid deletion of a good trace.

Fig-4 (a) a shows the frequency spectrum of the respective shot records shown in Fig-1 while Fig-4 (b) shows the same for high amplitude/cultural noise removed gathers. It is evident that the signal to noise ratio is improved by the removal of the unwanted noisy traces which would otherwise have contaminated the data in further processing.

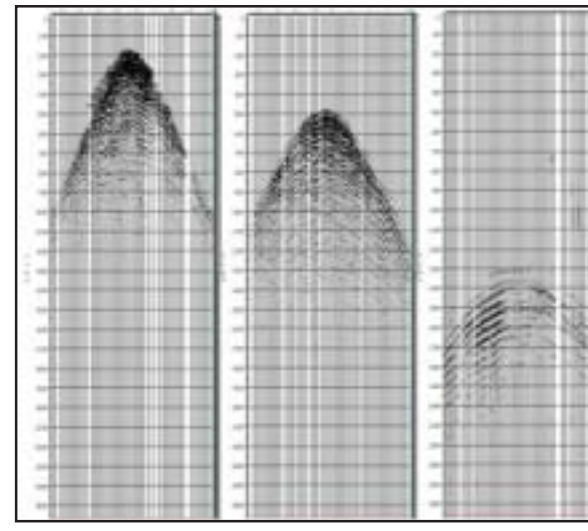

Fig-3: Same shot gathers with noise removed by present method.

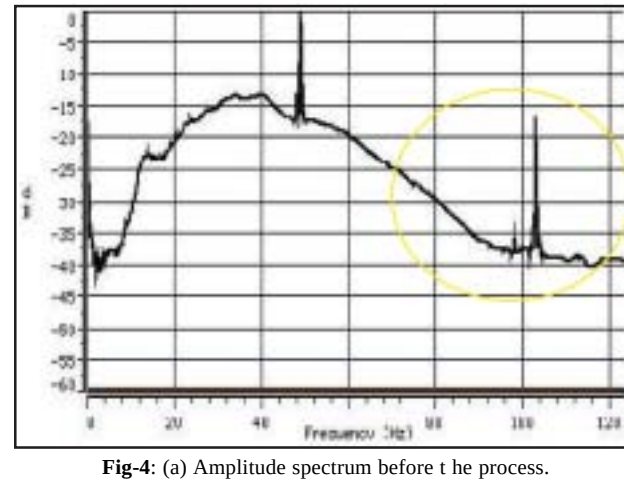

Fig-4: (a) Amplitude spectrum before t he process.

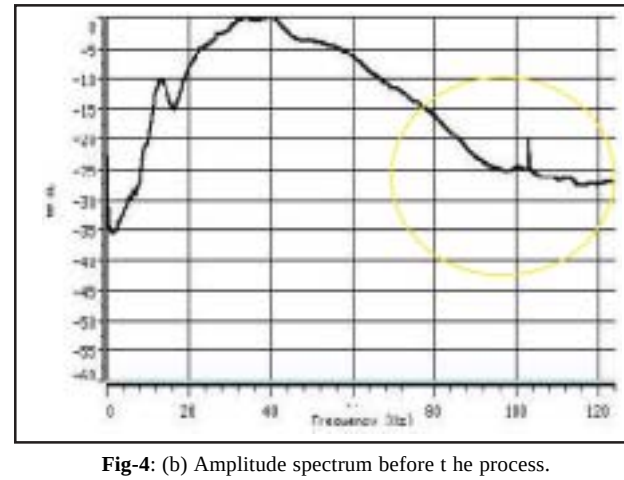

Fig-4: (b) Amplitude spectrum before t he process.

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Fig-5 shows the amplitude curves plotted against different offsets of the raw data, high amplitude/cultural noise removed by the present method and by automatic editing for comparison.

The amplitude curves show that the relative amplitudes areshowing the same behavior when the current method is used as against the auto editing (Fig-5 (a) to (c) This technique is much useful when already sufficient control has been exercised in containing cultural noise during data recording.

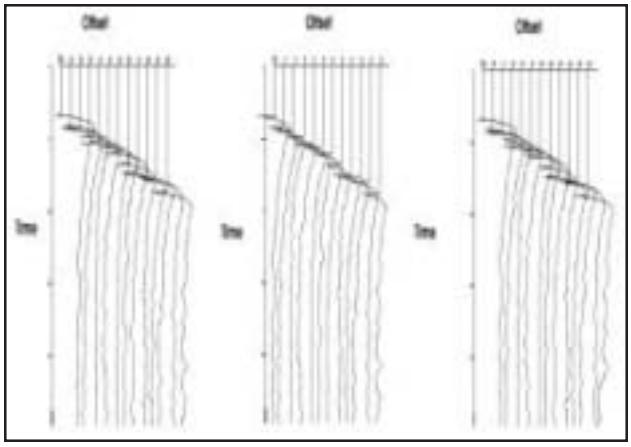

Fig-5: (a) Amplitude curve before process applied; (b) Amplitude curve after process applied; (c) Amplitude curve after auto editing.

Conclusions

When the present day land data volumes are growing in size with increase in number of channels, the processor cannot check to rectify all the traces of the volume. The method tested here best tackles the removal of the high amplitude noise and other cultural noise while preserving the relative amplitudes. This process enhances the signal to noise ratio of data, improving the quality to make fit for production of clean pre-stack gathers, improved velocity analysis and reliable AVO/AVA studies.

Acknowledgements

The authors sincerely thank Shri D. Dutta, GM-HGS and Shri Chaman Singh, DGM-SAOM for their help and constant encouragement to carry out this work and permitting to publish the same.

Views expressed in this paper are that of the author (s) only and may not necessarily be of ONGC.

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