EQUALIZING GAIN ON SEISMIC SECTIONS BY QUANTILES

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The aim of this technique is to equalize the "grey" level or noise level on all parts of a seismic section. This is accomplished by determining a two-dimensional gain function on a grid on the seismic section and then using spatial linear interpolation to determine the gain at a point.

The gain value at a grid point is defined as the reciprocal of the difference between the 30th and 70th percentiles of the amplitudes in a rectangle surrounding the grid point. The reasoning behind this is that, on the average, the probability density functions for the amplitudes of wave fields in the earth show very little deviation from the Gaussian probability density function for low amplitudes (noise). Thus, by equalizing the distance between the 30th and 70th percentiles on the section, a fairly constant grey level is introduced.

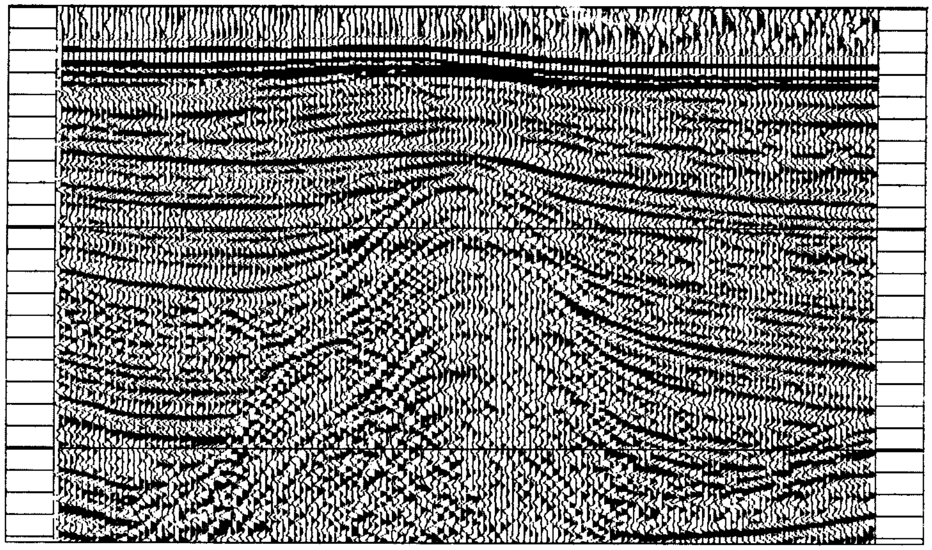
Figure 1(a) is a near trace section. Figure 1(b) is the same data with linear time variable gain applied to each trace. Figure 1(c) is the data processed with the space variable gain technique described above. It was made with a rectangle size of 16 traces by 128 msec. The dimensions of the section are 150 traces by 1.2 sec. The difference in quality between the conventional time variable gain and the space variable gain is quite striking when the area inside the salt dome is compared on all three sections.

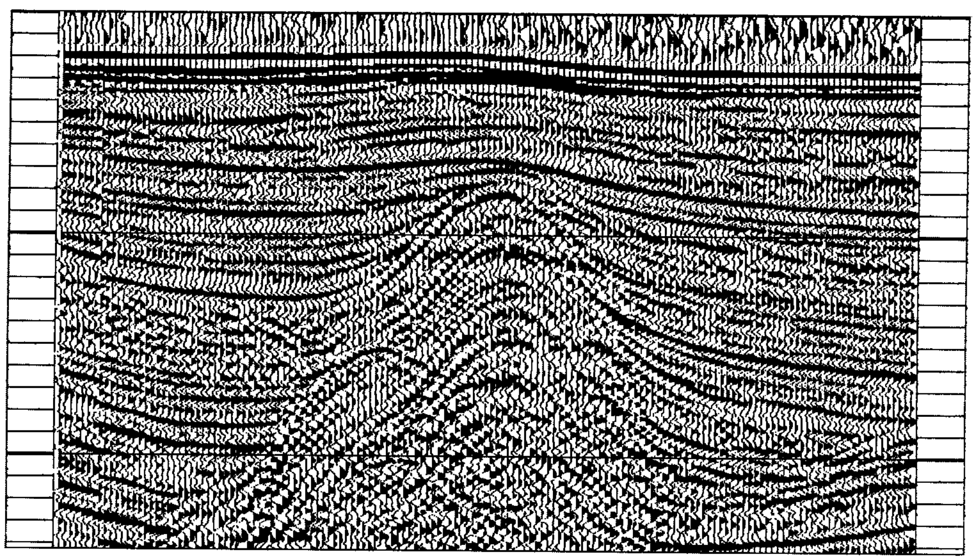
The dimensions of the rectangle used to determine the gain function will affect the efficiency of the gain control. They should be less than half the dimensions of the low-amplitude areas on the section. Reducing the rectangle size further will not affect the result greatly. Figure 2 shows how the gain algorithm responds to a high-amplitude seafloor reflection. This reflection is not compensated at all, even though, at later times, the gain level has been perfectly adjusted. The reason is that the duration of the seafloor arrival is only 64 msec, while the dimensions of the rectangle used to determine the gain function were 128 msec by 16 traces. Figures 3(a) and

3(b) show the efficiency of the gain control for two different rectangle sizes. Figure 3(a) was processed with a sample rectangle 32-traces wide and Fig. 3(b) with one 16-traces wide. The time dimension of the rectangle was 128 msec in both cases. The gain control algorithm was not able to compensate for all the low amplitudes in the salt dome in Fig. 3(a), whereas it worked well in Fig. 3(b) because of the reduced rectangle size.

The problem of choosing a clip level to plot such data, which has a few high amplitudes, is solved by quantiles, also. If, for example, we set the clip level at the 90th percentile, we ensure that 10% of the amplitudes will be clipped. Figure 4 shows some traces plotted with the clip level at the 99th, 96th, 93rd, and 90th percentiles. Setting a clip level at the 99th percentile corresponds to the standard practice of using some fraction of the maximum value as the clip level. Setting the clip level at the 90th percentile, instead, produces a much more useful display. From past experience, this appears to be a very robust way of setting the clip level.

(a)

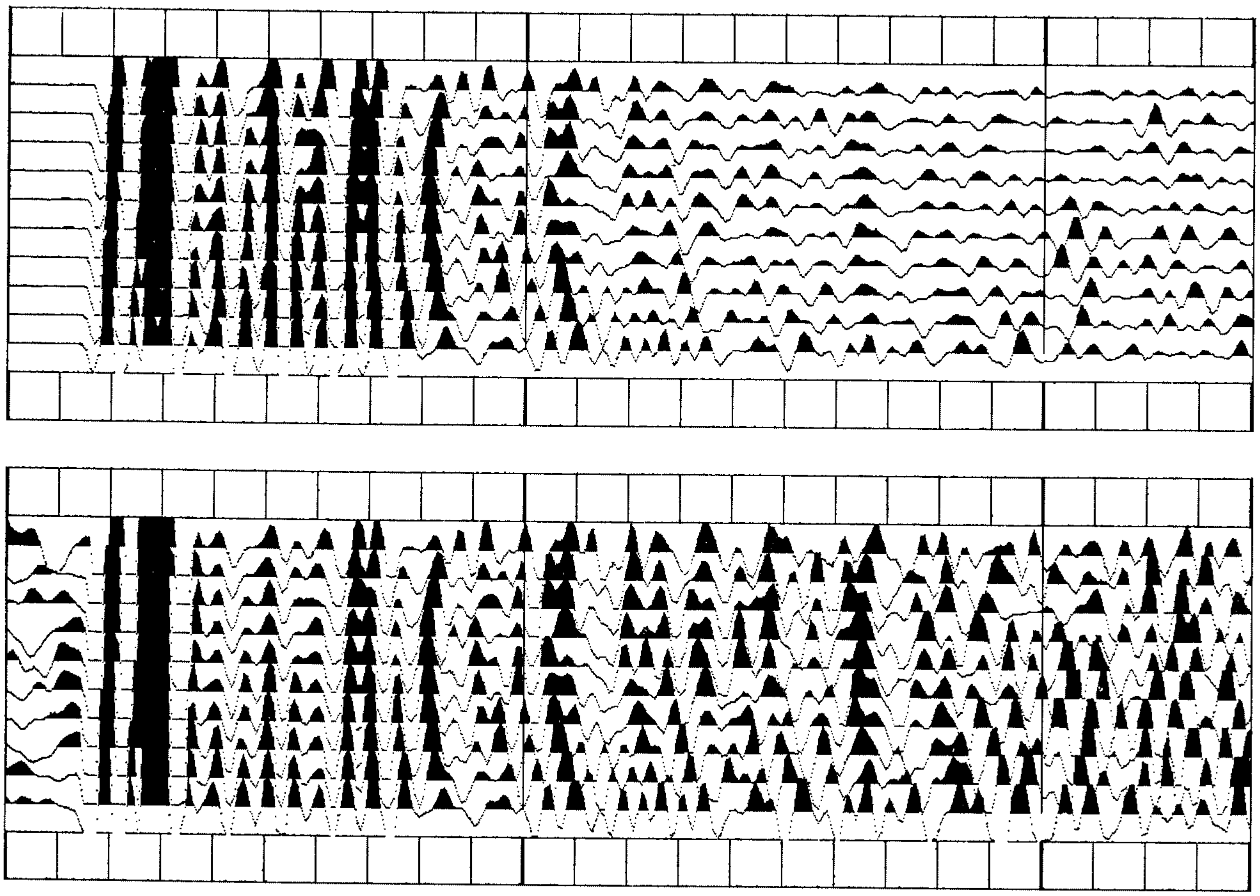




(b)

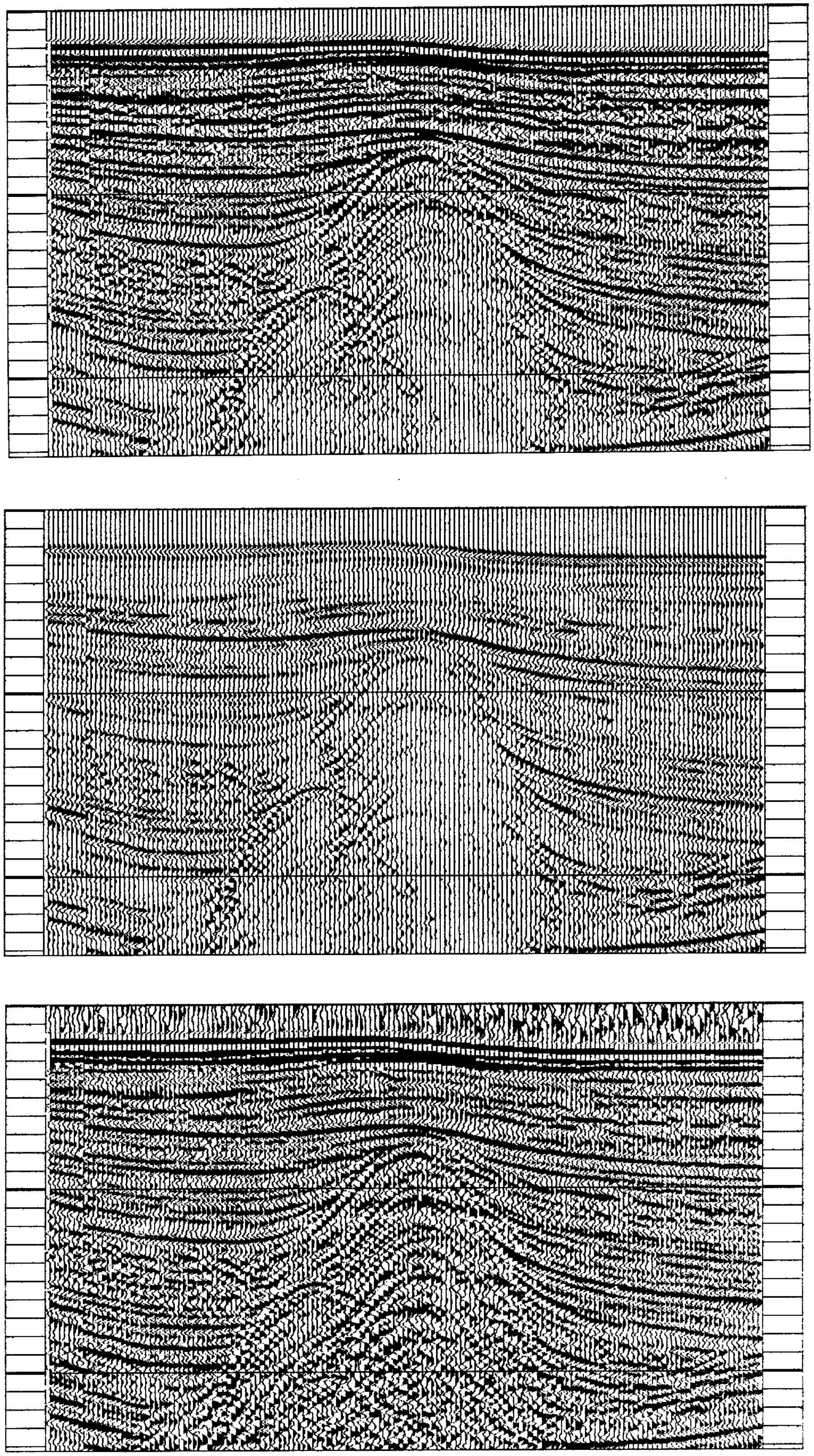
FIGURE 3.—A comparison of space-variable gain control with two different rectangle sizes. The time dimension of the rectangle was 128 msec in each case. Figure 3(a) was made with a rectangle 32-traces wide and 3(b) with one 16-traces wide. The smaller rectangle size produces more uniform gain control.

(a)



(b)

FIGURE 2.—A closer examination of unprocessed and gain-controlled traces. Figure 2(a) shows the unprocessed traces and Fig. 2(b) the gain-controlled traces. Note that the extremely large amplitude seafloor arrival has not been affected by the gain-control algorithm because its duration is much shorter than the dimensions of the rectangle used for gain determination.



(a)

(b)

(c)

FIGURE 1.—A comparison of space-variable gain with time-variable gain. 1(a) is the unprocessed section, (b) has linear time-variable gain applied to each trace, and (c) was produced by the space variable gain method described in the text. The clip level was set at the 90th quantile of the first trace plotted in each case. The time scale is arbitrary. An examination of the area in the middle of the section between 1 and 2 sec illustrates the efficiency of the space variable gain control.

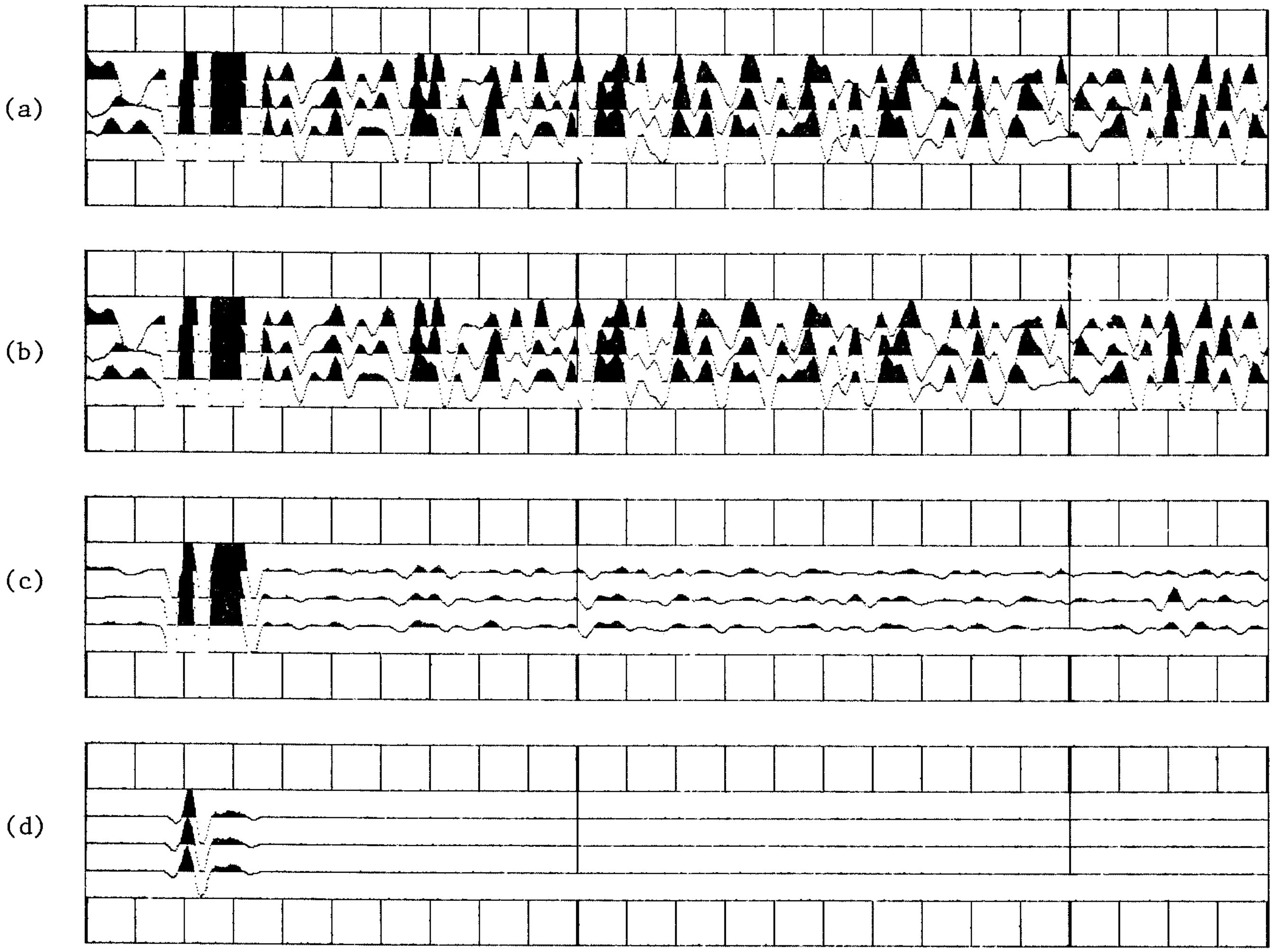


FIGURE 4.—This figure illustrates the use of quantiles for setting clip levels. The traces in Figs. 4(a), (b), (c), and (d) were plotted with the clip level at the 90th, 93rd, 96th, and 99th percentiles, respectively.