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SOURCE MULTIPLICITY EXAMINED WITH MINIMUM ENTROPY DECONVOLUTION

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13. ABSTRACT (Maximum 200 words) This report contains the preliminary results of a study to determine the usefulness of minimum entropy deconvolution in detecting seismic source multiplicity and its potential for discriminating ripple-fired explosions from other seismic events. Several specific examples of its application to data known or suspected to be from commercial explosions are presented. The method's ability to detect regional phase arrivals as well as source multiplicity is discussed.			
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1. OBJECTIVES

The contractor's objective in the first year is to develop a technique, based on minimum entropy deconvolution (MED), useful for discriminating ripple-fired explosions from other seismic events.

2. PROGRESS

An interactive X-Windows program, using modules developed for the Nuclear Monitoring Research and Development (NMRD) initiative, has been developed to analyze the effects of MED filters on explosion data. Using this program, we have started to evaluate the effects of the use of various parameters in the problem: filter length, damping coefficient, data window position and length. The algorithm for generating an MED filter is based on an iterative search for the local minimum of a specific norm of the windowed data. The program permits interactive analysis and evaluation of the evolution of the filter, as well as its effect on the data, after each iteration by visual monitoring and intercession. We have found that the "best" filter is frequently encountered before a local minimum is reached.

We have examined signals from the Soviet/NRDC database. The sample rate for these data is 250sps, and many events are believed to be commercial explosions. In one example, a particular linear filter was found which transforms the data segment (Figure 1a) into a series of irregularly spaced impulses (Figure 1b). These impulses have interphase arrival delays of the correct order of magnitude for regional phases at this distance. Note that the time separations between the doublets are uniform (Figure 2).

The data analyzed from the Soviet/NRDC database were recorded with high-gain surface instruments. Figure 1a shows data recorded at station Karkaralinsk (KK) for an event at (49.9N, 73.1E), at a distance of 1.6 degrees. The data window shown is approximately 6.0 seconds of data, starting just before the Pg arrival. A 2.8-second (700 point) MED filter was generated for this data window. The filtered data is shown in Figure 1b. The MED algorithm does not constrain the phase of the filter, and the output of the filter operation is therefore time shifted by an arbitrary amount. The filtered data contains four dominant spikes, with time separations of .34 sec, .16 sec and .52 sec. Three of the spikes appear as doublets, uniformly separated by 47 msec, suggesting source multiplicity.

We obtained data at the end of the second quarter from a recent known quarry blast in Oklahoma, along with a description of the shot geometry and delay times. The shot description is shown in Figure 3. The typical shot delay time is approximately 8msec. Since the data sample rate is 60sps (16.67msec sample interval), we can not deconvolve the individual shots in this case. Figure 4 shows a spectrogram of the first 1.5 seconds of a signal from the quarry blast, recorded with a borehole instrument approximately 32km from the quarry. There are two prominent spectral lines at approximately 42msec (23.8Hz) and 59msec (16.9hz), which would appear to be directly related to the shot delay times.

Figure 6 shows the effect of a 50 sample MED filter on the first 1.2 seconds of the signal, as shown in Figure 5. The deconvolved signal contains 4 spikes with time

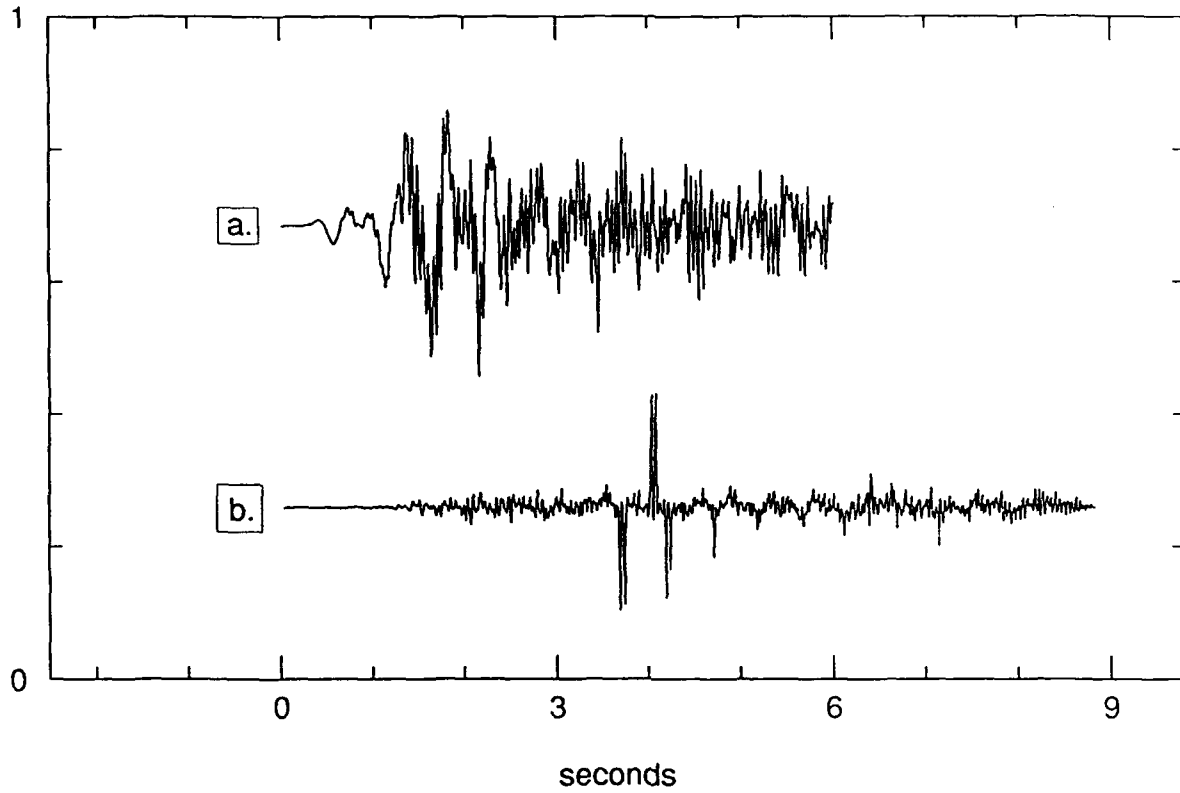


Figure 1. a) Vertical component record from station KK for an event at (49.9N, 73.1E), Mar 20, 1987, 08:07:41. b) The same data filtered with a 750 point filter.

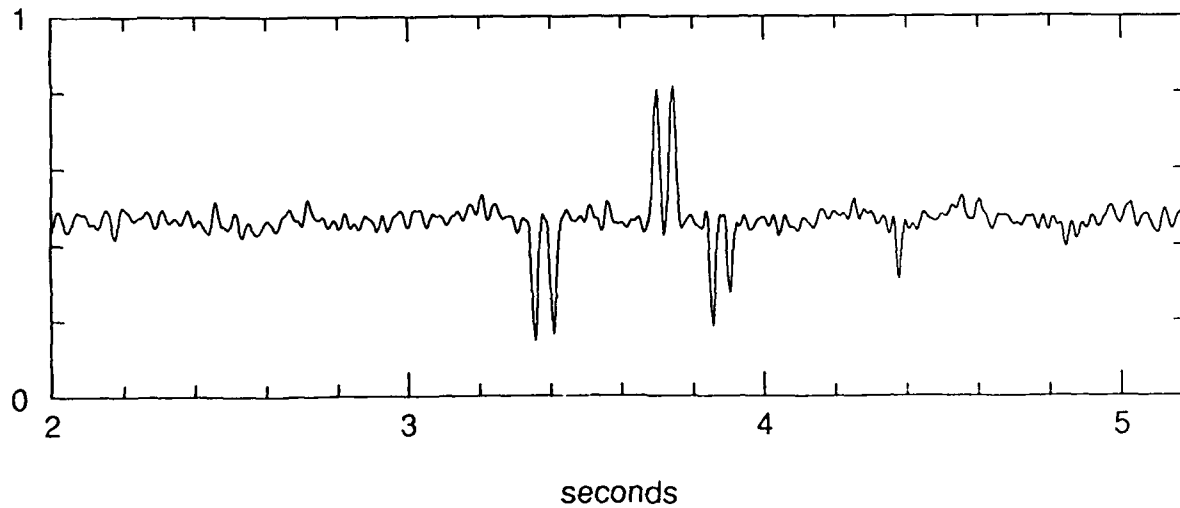


Figure 2. The deconvolved signal from Figure 1b enlarged to show the doublet nature of the impulses.

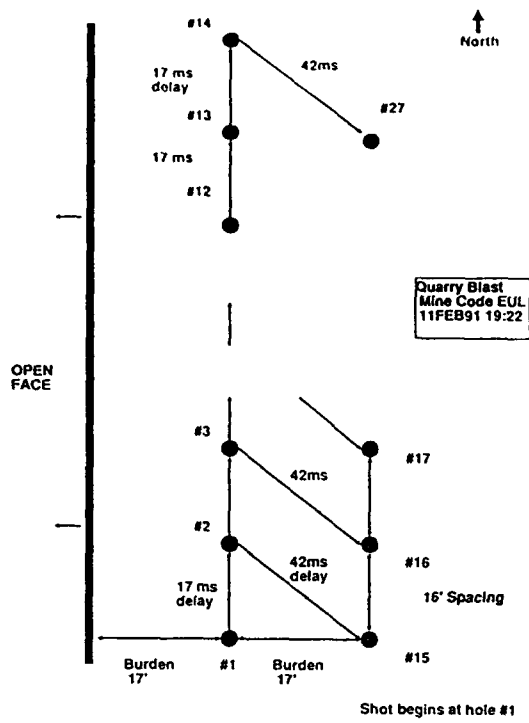


Figure 3. Quarry explosion timing and layout.

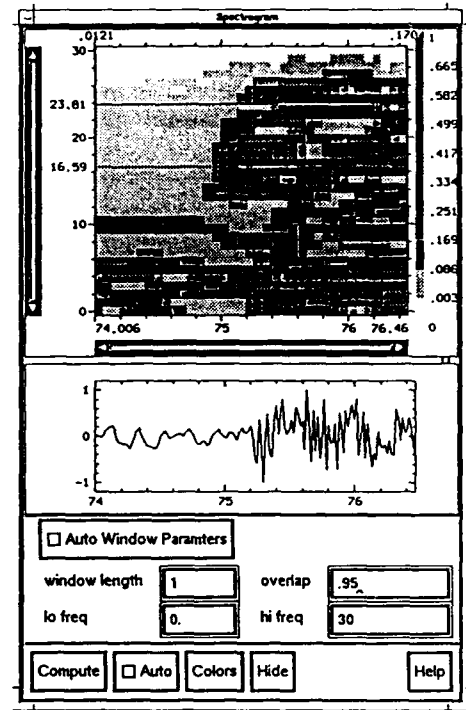


Figure 4. Spectrogram of explosion example showing peaks at 16.6 and 23.8Hz discussed in text.

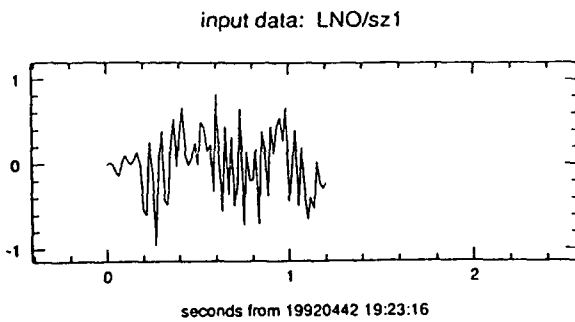


Figure 5. Explosion signal used as input to Med filter

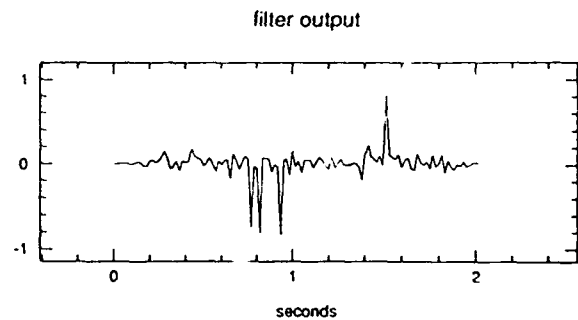


Figure 6. Output from 50-sample MED filter on first 1.2 seconds of signal shown in Figure 3.

separations of 52 msec, 119 msec, and 580 msec. This result may be related to the source multiplicity.

3. FUTURE PLANS

Further analysis of the data sets with which we are currently working should determine whether any of the impulse signals we obtain with the MED filter are related to regional phase arrivals. We intend to acquire data from known quarry explosions, sampled at a higher rate than the data with which we are currently working, to test further the usefulness of this method in detecting source multiplicity.

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