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Near-Surface Investigation Using High-Resolution Seismic Reflection Techniques

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SUMMARY

The shallow seismic technique has been used to see subsurface, 595 meters of high resolution seismic reflection profile were carried out. The data were acquired using a Strata Visor with 48-channel, 40 Hz geophones and a vibroseis "IVI Minivib" system as a seismic source. Seismic reflection data were recorded using a CMP (common mid-point) acquisition method. The results for Al muzahimiyah Line are good and show a considerable improvement in signal to noise ratio. There were some problem during processing such as multiples, noise and it was so difficult to see first break because of high frequency. Signal to noise ratio was good in general. Frequent testing was carried out to improve the signal.

Key words: shallow seismic technique; vibroseis.

INTRODUCTION

The shallow seismic reflection methods have been widely utilized to detect and map subsurface features, especially the layered sedimentary sequences in search of oil and gas reservoirs (Burger et al., 1992). One of the advantages of shallow seismic techniques over other geophysical methods is due to their high accuracy, high-resolution and deeper penetration (Sheriff et al., 1999). Recently, the shallow seismic methods, which include the high-resolution seismic reflection method, have been applied to characterize near-surface structures, depth of water tables and identification of engineering related problems (Kearey and Brooks, 1984). Since, all the engineering and environmental aspects are located at shallow depths (near surface); seismic reflection techniques are an excellent choice to achieve high-resolution images from that domain. The survey covered 1 line of high-resolution seismic reflection with a total length of 595 m in Al muzahimiyah, about 60 km towards west from Riyadh city. The objective of the survey was to map near-surface sedimentary layer and high-resolution seismic reflection efficiency.

Data acquisition and processing

The instruments used here are the most advanced and up-to-date sold commercially for high- resolution investigation. The system consists of the source which is a weight drop, sensors, and the acquisition system. The sample rate kept was 0.5 ms and the record length of 2 s. acquisition parameters are outlined below.

DESCRIPTION	VIBROSEIS DATA
Source Interval	01 M
Recording Geometry	Left off-end shooting
Receiver Interval	05 & 10 m
No. Of Channels	112
Maximum Far Traces Offset	575 m
Minimum Offset	20 m
Nominal Fold	92
Acquisition Sample Rate	0.5 ms
Processing Sample Rate	0.5 ms
Acquisition Record Length	2 sec

The acquired high-resolution seismic reflection data were processed to enhance signal to noise (S/N) ratio, for which Landmark's ProMax Software Package has been used. Fig. 1 & 2 shows an example of shot gather. In general terms, processing steps of the shallow seismic reflection data is similar to that of conventional seismic reflection data (Steeples et al., 1990; Feroci et al., 2000). In general, the near surface layers have a low velocity value that varies abruptly with lateral extension, which often make seismic reflections subtle and noisy. Hence, as compared to conventional processing techniques, more attention must be paid when we process the high-resolution data e.g., ground roll, removing of air-blast noise, spatial aliasing and refraction muting (Steeples et al., 1998; Steeples, 2000).

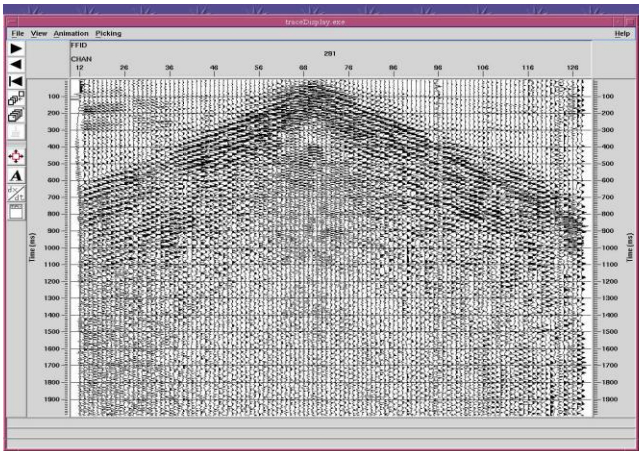

Figure 1. Shot gather for file # 1.

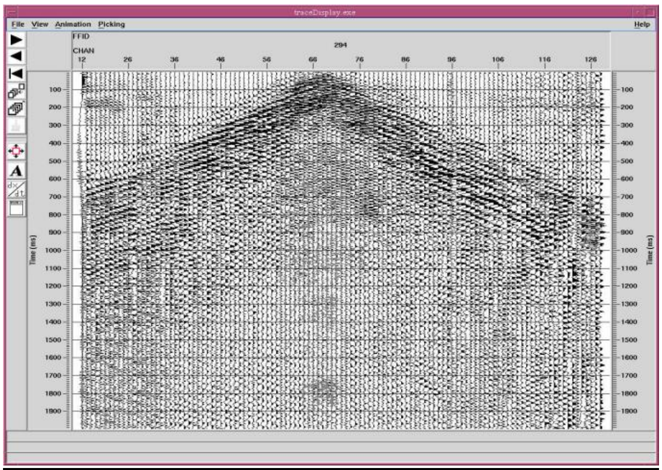

Figure 2. Shot gather for file # 2.

True Amplitude Recovery was applied to the data. Numbers of tests were performed for TAR (dB/second). The seismic trace can be represented as the convolution of the source signal with the instruments, the geophones, and the response of the earth. The earth response includes some undesirable effects, such as reverberation, attenuation, and ghosting. The purpose of deconvolution is to remove the effects of unwanted signatures such as multiples, or a long seismic wavelet by deconvolving them with the seismic trace.

Autocorrelations on records revealed that there were significant reverberations in the data. A Surface Consistent Predictive deconvolution was applied to predict and remove these reverberations. An operator length of 150 msec and Predictive Distance of 06 msec was finally selected after testing. Fig. 3 & 4 show spectral analysis before/after deconvolution.

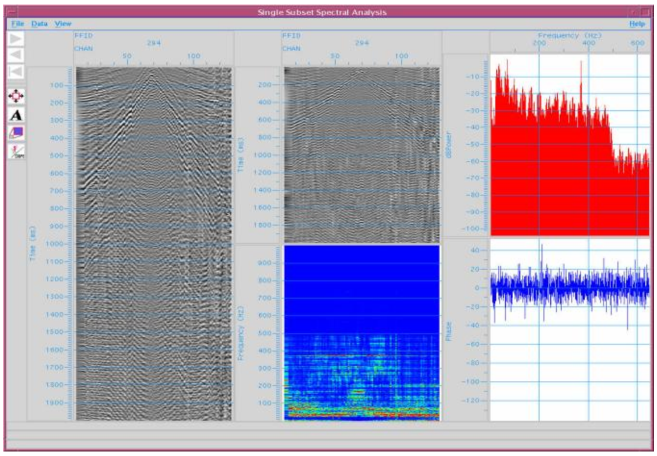

Figure 3. Spectral analysis before deconvolution.

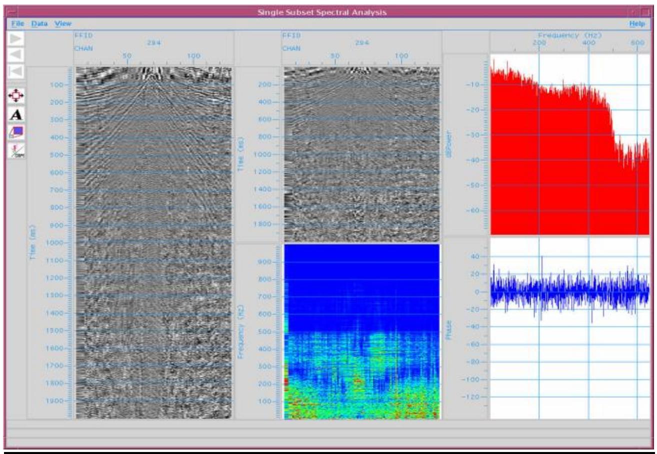

Figure 4. Spectral analysis after deconvolution.

Results

The main purpose of this study is to map near-surface sedimentary layer and high-resolution seismic reflection efficiency. Figs. 5 and 6 present the final stack of reflection data in time scale with different receiver intervals.

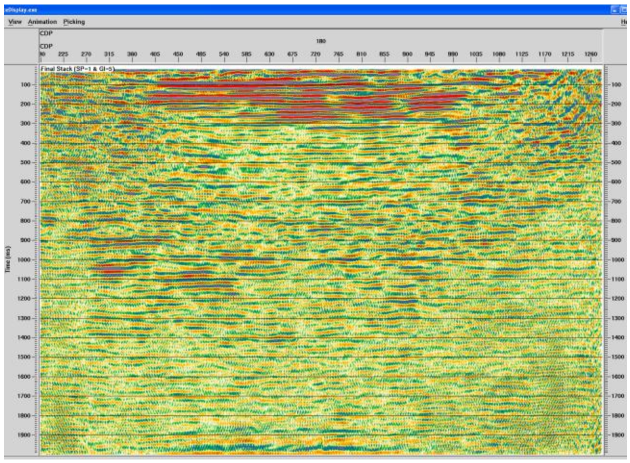

Figure 5. Final stack of reflection data with source interval 1 m and 5 m for receiver interval.

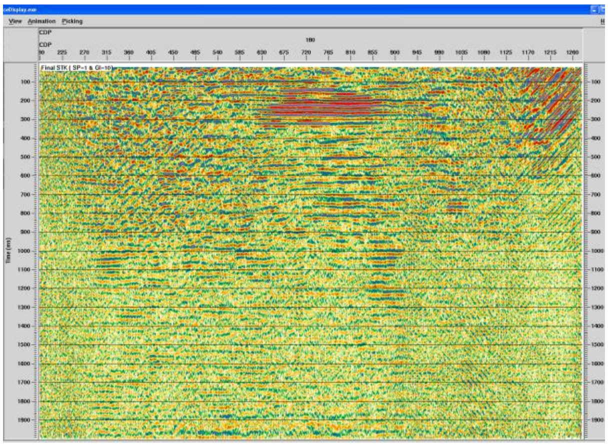

Figure 6. Final stack of reflection data with source interval 1 m and 10 m for receiver interval.

CONCLUSIONS

The shallow seismic reflection technique has been shown to map near-surface sedimentary layer. This study was initiated with acquiring 2D high-resolution seismic reflection data over about 595 m line length consisting of 1 seismic line. Using 5 m for receiver interval shows clear results compared to 10 m.

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