

PROJECT R01/02

075.01

RSG / PIP

31 MAY 2001

Irish Margin

**Digital Processing  
of  
High Resolution Seismic Data**

by

**Hydrossearch Associates Limited  
Job Number 01042**

**April 2001**

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## EXECUTIVE SUMMARY

Improvement in data quality was improved through noise attenuation techniques, stacking and migrating of the data. The integrity of certain processes and of the final product should be regarded with caution, however, as lack of reliable navigation and information on missed shots resulted in assumptions being made in the processing which, under normal circumstances, would not have been taken.

INTRODUCTION PARAMETERS

In August 2000 The Netherlands Institute for Sea Research (NIOZ) acquired four lines of high resolution seismic data ( STRAT06, STRAT07, STRAT08 and STRAT09 ) across the NE Rockall Basin slope. This report describes the digital processing carried out on these data by Hydrossearch Associates Limited utilising ProMAX processing software system run on a unix (Sun) hardware platform. The acquisition parameters are tabulated below.

|                   |                         |
|-------------------|-------------------------|
| Gun Volumes       | 80 cu lns               |
| Gun Depth         | 3 m                     |
| Pop Interval      | 12.5 m ( nominally )    |
| Sample Rate       | 8000 Hz                 |
| Anti-alias filter | 4800 Hz slope of -74 dB |

OBJECTIVE

These lines were acquired to obtain more detailed information on the character of recent and sub recent surface sediments and to help define the seismic stratigraphy and sedimentary processes from the shelf break downslope, in an area of particular interest for the Rockall Studies Group (RSG), covered by Project 01/006. By applying various processing techniques to the data it was intended to improve the data continuity, character and resolution over that of the raw data as supplied thus allowing the interpretation of the dataset and integration with existing seismic data.

EXECUTIVE SUMMARY

Raw data was delivered to Hydrossearch in SegY format on CD along with the navigation data. Improvement in data quality was improved through noise attenuation techniques, stacking and migrating of the data. The integrity of certain processes and of the final product should be regarded with caution, however, as lack of reliable navigation and information on missed shots resulted in assumptions being made in the processing which, under normal circumstances, would not have been taken.

- The navigation data supplied contained many duplicate coordinate values for differing shot locations.
- Calculating the pop interval by taking the first and last shot point coordinate for a line and dividing by the number of shots resulted in an average shot interval greater than 12.5 metres.
- No information was supplied on the frequency and location of any missed pops.
- Observation of the timing of the water bottom and the first multiple over the shelf indicated that there was a delay within the recording of the data though this was not documented.

As there was no actual information regarding missed pops for the processing of the data it was assumed there were no missing stations and the live shots

## ACQUISITION PARAMETERS

The four lines to be processed were acquired simultaneously with an experimental 3D acquisition where the cable used to record the data described in this report was located straight astern of the boat and two gun arrays were located either side of this cable; the two cables used to record the 3D acquisition were on booms either side of the boat. Shooting was via a flip-flop manner and the 2D cable was made up of six channels. The acquisition parameters are tabulated below.

|                      |                         |
|----------------------|-------------------------|
| Gun Volumes          | 80 cu ins               |
| Gun Depth            | 3 m                     |
| Pop Interval         | 12.5 m ( nominally )    |
|                      |                         |
|                      |                         |
| Minimum Offset       | 69 m (average)          |
| Maximum Offset       | 162.75 m                |
| Perpendicular Offset | 4.6 m                   |
| Group Interval       | 18.75                   |
| Cable Depth          | 3 m                     |
|                      |                         |
| Sample rate          | 0.33                    |
| Anti-alias filter    | 4800 Hz slope of -74 dB |

Raw data was delivered to Hydrosearch in SegY format on CD along with navigation data and some poor quality xeroxed handwritten notes on the recording activity. The following observations can be made on the data delivered.

- Coordinate information was not available in the trace headers
- The navigation data supplied separately did not contain all sequential shot locations.
- The navigation data supplied contained many duplicate coordinate values for differing shot locations.
- Calculating the pop interval by taking the first and last shot point coordinate for a line and dividing by the number of shots resulted in an average shot interval greater than 12.5 metres.
- No information was supplied on the frequency and location of any missed pops.
- Observation of the timing of the water bottom and the first multiple over the shelf indicated that there was a delay within the recording of the data though this was not documented.

As there was no actual information regarding missed pops for the processing of the data it was assumed there were no missing stations and the live shots



would be spaced evenly from the start to the finish of the line. The table below lists the calculated line lengths, the number of shots and the resultant average pop interval.

| Line Number | Line Length (m) | Number of Pops | Pop Interval (m) |
|-------------|-----------------|----------------|------------------|
| STRAT 06    | 42439           | 2992           | 14.18            |
| STRAT 07    | 50150           | 3387           | 14.81            |
| STRAT 08    | 32893           | 1289           | 25.52            |
| STRAT 09    | 32889           | 2246           | 14.64            |

• Automatic despiking, noise burst removal and bad trace edit

- On the initial loading of the data it was observed that the data was fairly heavily contaminated with spikes and noise bursts. Algorithms within ProMAX allow these to be identified through windowed analysis of traces. By comparing rms amplitudes within defined windows to traces either side and windows above and below on the same trace then amplitudes exceeding defined thresholds can either be zeroed or replaced through interpolation. In several instances whole pops were observed to be bad and these were zeroed before any further processing. Figures 1 and 2.

• Bandpass Filtering

- The raw data had extremely high levels of low frequency noise present over all the traces, to the extent no signal was observable until a bandpass with a low cut of 60 Hz was applied. From the power spectrum it can be seen that the main signal band lies between 60 to 300 Hz and this range is 35db down when compared to the noise power level. Hence a high cut filter of 300 Hz was applied to improve data resolution through the removal of high frequency noise apparent within the dataset. This process was fundamental in the whole sequence to providing a good quality product from the supplied data. Figures 3, 4 and 5.

• Trace Mix

- Acquisition was via a flip-flop operation using two gun arrays that though having the identical gun volumes had a different gun signature and this was apparent on the shot records. This difference manifested itself as a 'saw-tooth' appearance on events, especially the water bottom reflection. By applying a

## DATA PROCESSING

The processing effort was mainly concentrated around noise attenuation techniques as it was recognised that these would provide the greatest benefit to this dataset due to its low fold nature, the very high resolution of the recording and the shallow objectives of the survey.

The processing parameters applied to the data are listed below in the order they were applied and observations are made on each process.

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- **Trace Mix**

- Acquisition was via a flip-flop operation using two gun arrays that though having the identical gun volumes had a different gun signature and this was apparent on the shot records. This difference manifested itself as a 'saw-tooth' appearance on events, especially the water bottom reflection. By applying a

3:1 running trace mix with weights of 1:2:1 these events were smoothed and improved data continuity and character resulted. Figure 5.

- **FX Deconvolution**

- This process transforms the data into the FX domain and improves data continuity identified through frequency, it thus reduces random noise in a dataset that has a frequency component different to the signal frequency. Figure 6.

- **Scaling**

- AGC in a 100 msec gate greatly improved the deeper events on display. However this improvement does have to be offset against the loss of any relative amplitude preservation.

- **Stack**

- The data was CDP binned and stacked to give a 6 fold, stack output. Stacking improved data continuity in part and again provided random noise attenuation. This process however was impacted by the assumption made in evenly spacing the live pops along the line and hence it was most probable traces were binned into a stacked CDP trace that in actuality were many metres apart. NMO was not applied prior to stack as tests indicated that little improvement was gained and in some instances NMO application degraded the data. This was especially true at sea bed level in areas of high dip. Figure 7.

- **Migration**

- Many diffractions, especially at sea bed level, were present in the data and by migrating, using a simple phase shift algorithm, with a constant velocity of 1480 m/s (water velocity) these diffractions were collapsed and this process would aid the interpretation of the final product. Figure 8.

- **Recording delay**

- Once data from STRAT 07 that traversed over the shelf into shallower waters was processed it was observed that by comparing water bottom and first period multiple times there was a delay in the recording system at some point, however this was not documented. By measuring these arrival times on paper displays it was considered appropriate to apply a -41 msec correction to all the delivered outputs to bring the data to an approximate real time. A correction of +4 msec was also applied to correct for gun and cable depths.

After processing the data was delivered in the form of paper sections and digital data in SegY format as four different products.

1. Simple single channel (near trace) display with all processes up to AGC applied
2. A migrated single channel (near trace) display with all processes except stack.
3. A 6 fold stack display of all channels with all processes to CDP stack applied.
4. A migrated 6 fold stack display of all channels with all processes applied.

Each product provided points of interest and added value to the interpretation of the survey and it was considered that the interpreter would benefit from having all four products available.

## **CONCLUSIONS**

By applying various noise attenuation techniques and stacking and migrating the data products were made available to the interpreter that were a great improvement in term of data continuity and resolution than would have been available before processing. This improvement in data quality is considered to outweigh any detrimental effects that may have occurred due to the assumptions made, in the data processing, of the data acquisition.

## **RECOMMENDATIONS**

If any further high, resolution surveys are to be acquired and processed in this manner then greater confidence in the output of the data processing would be had if missed pops were noted and the tie between the navigation and seismic data was improved. Utilising guns with the same signature would also be recommended.



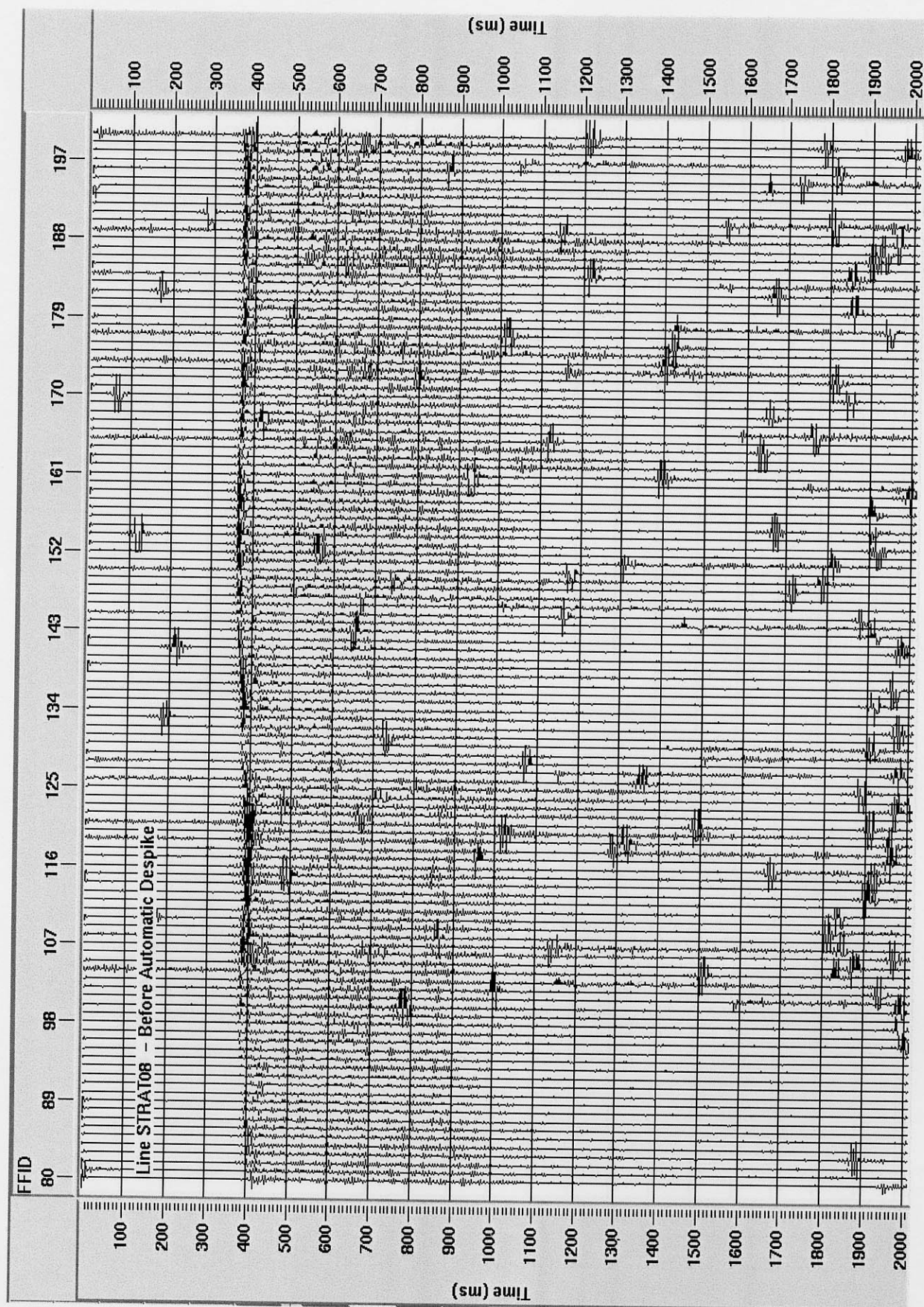


Figure 1



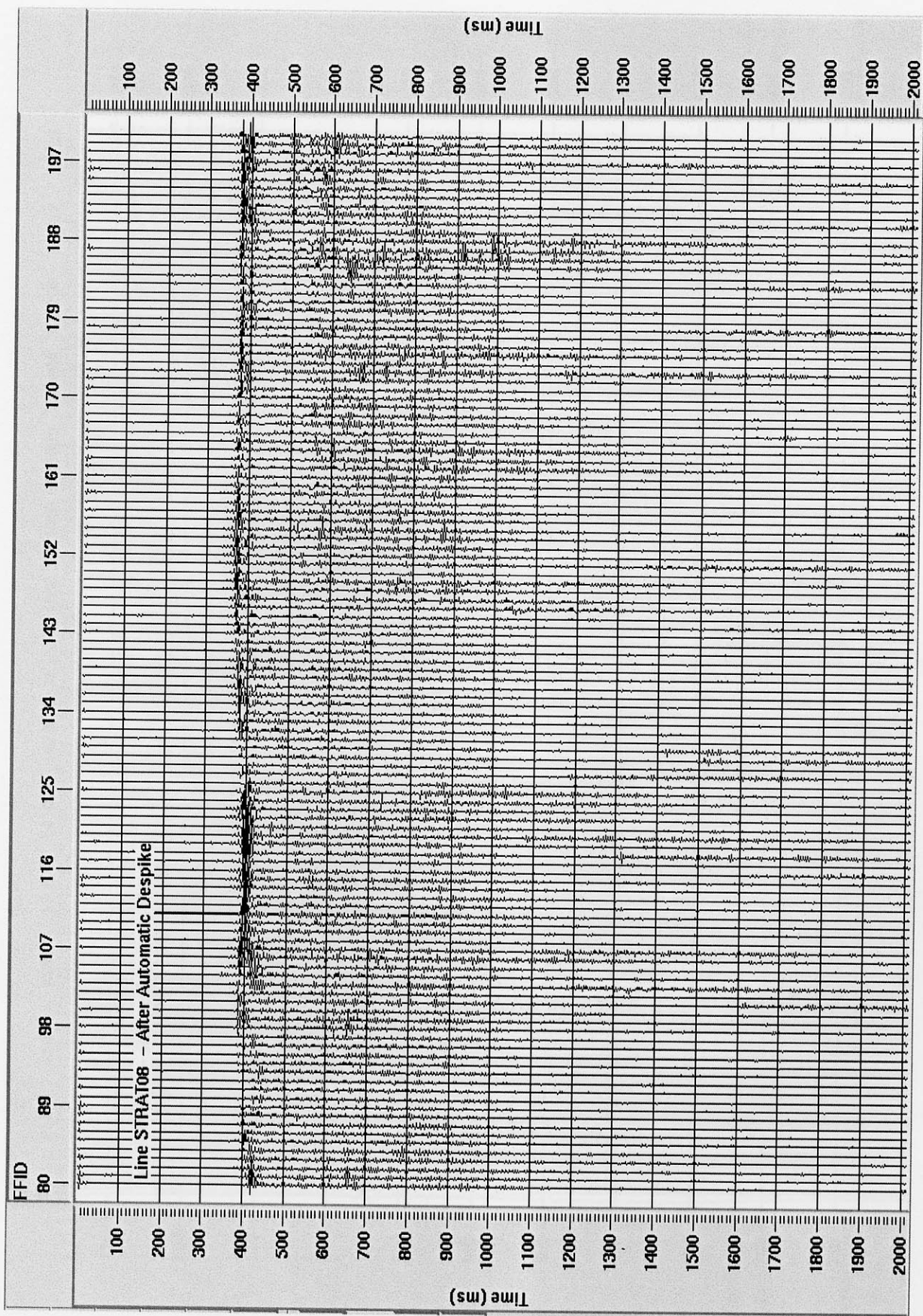


Figure 2

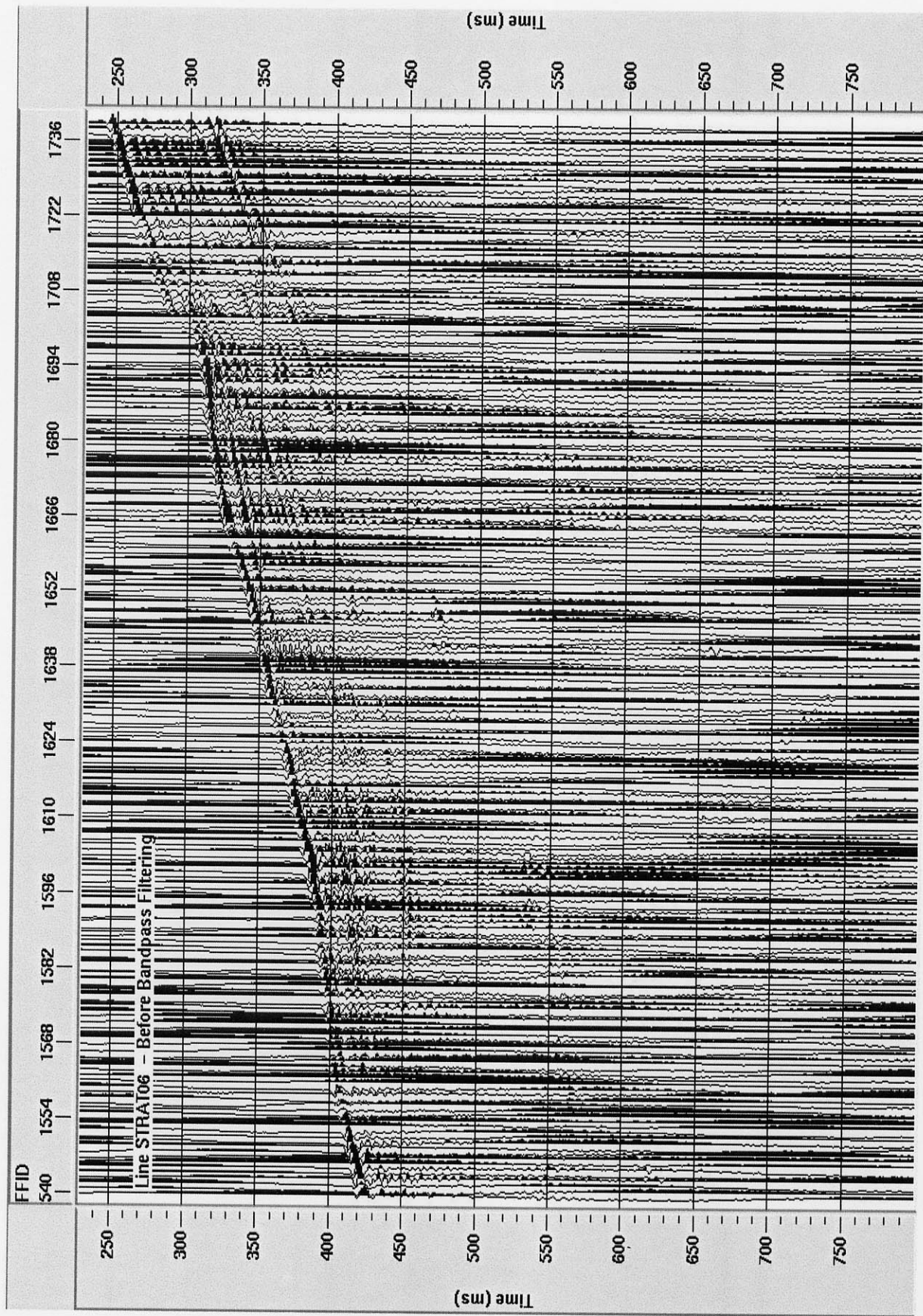


Figure 3





Figure 4



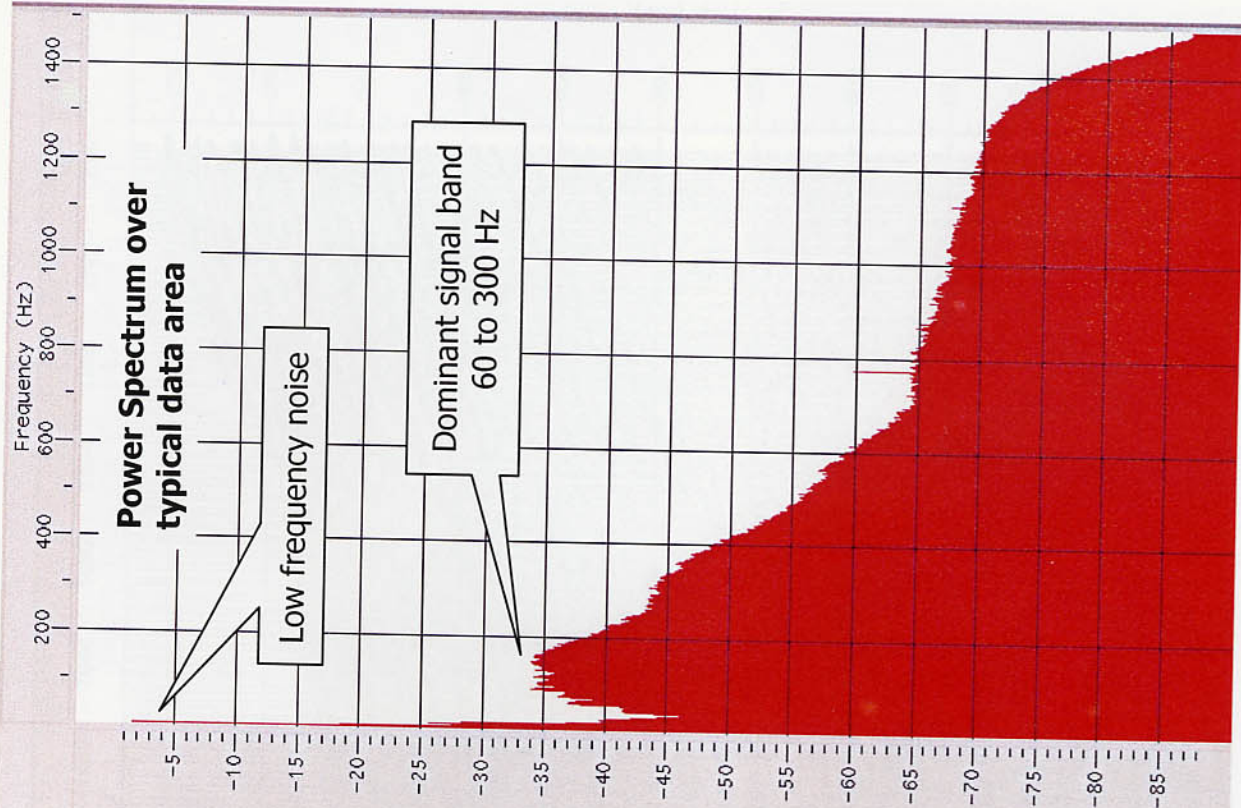
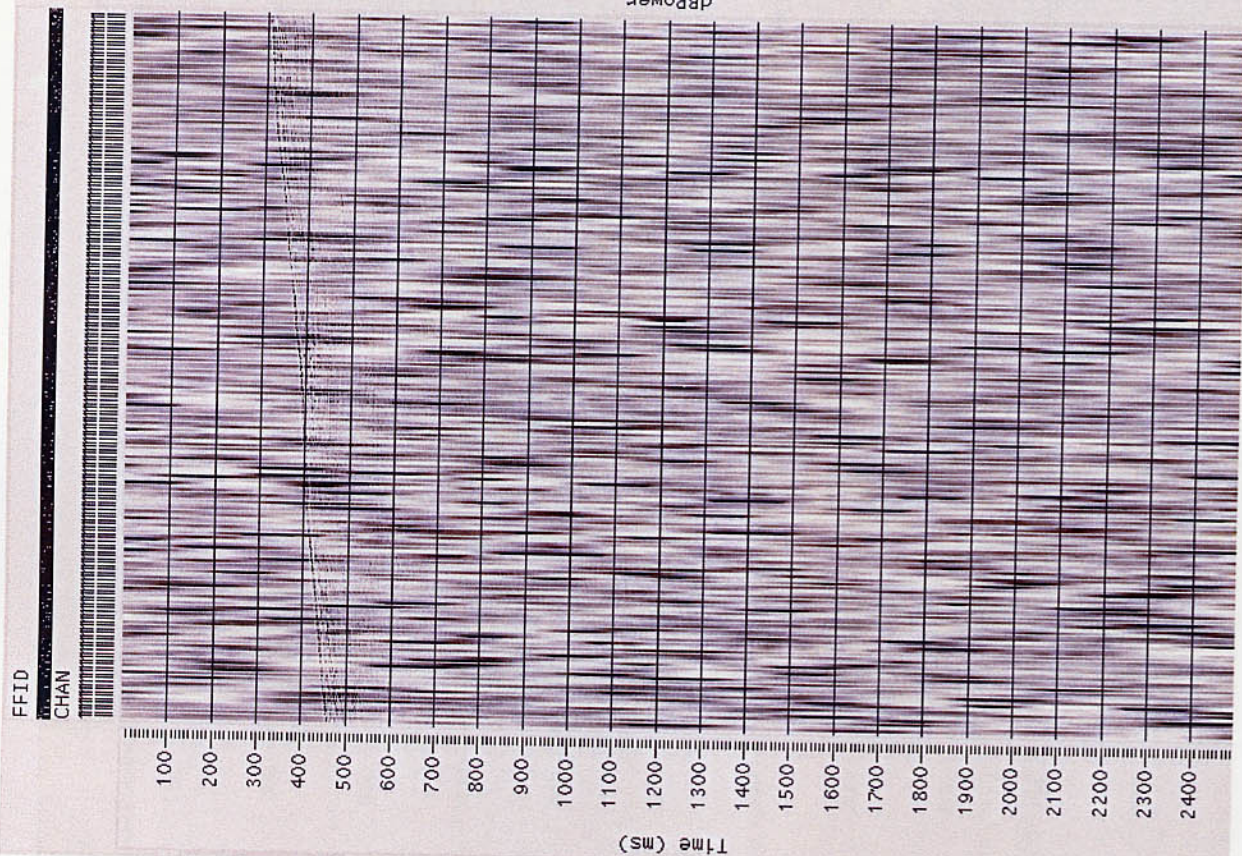


Figure 5



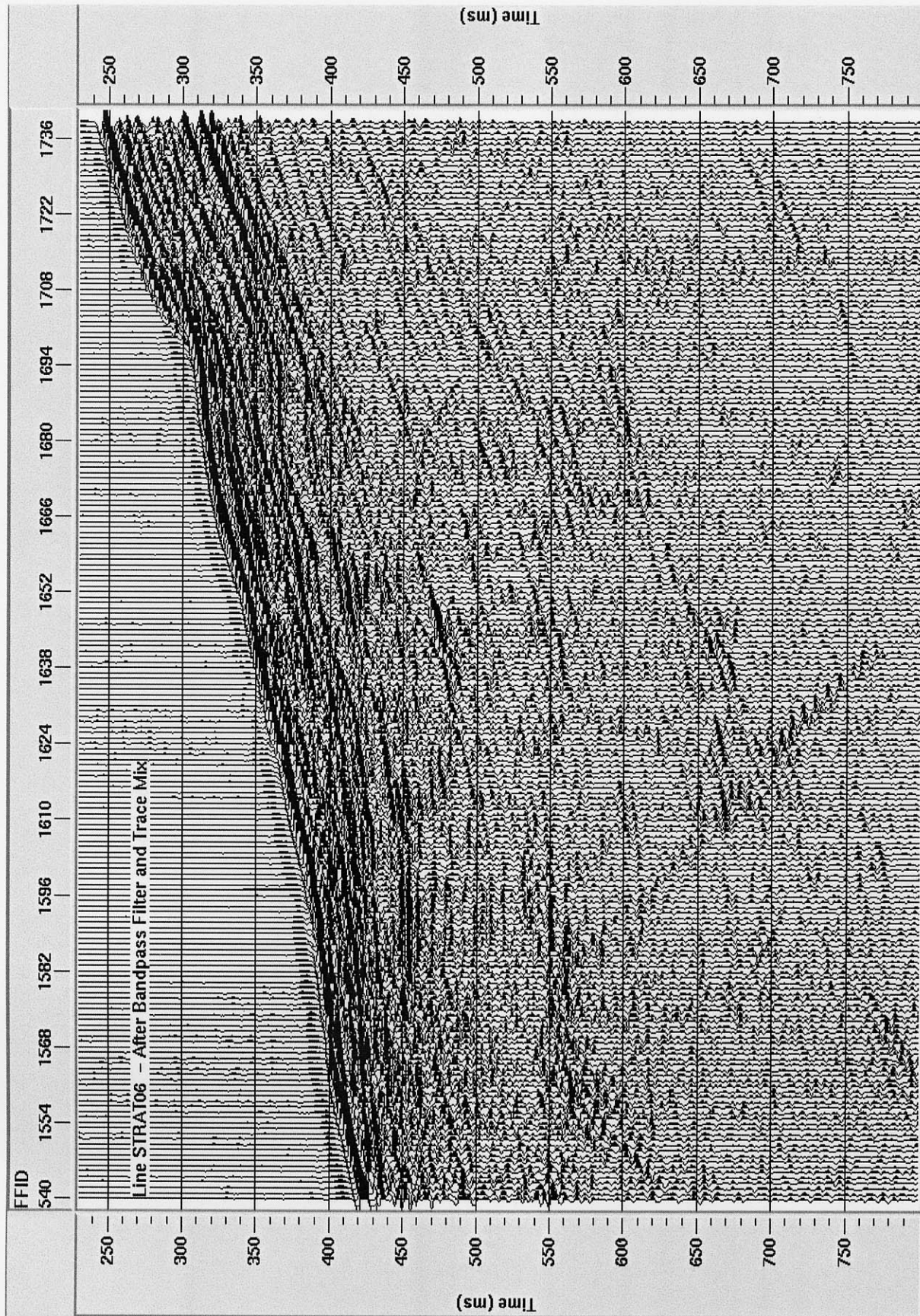


Figure 6

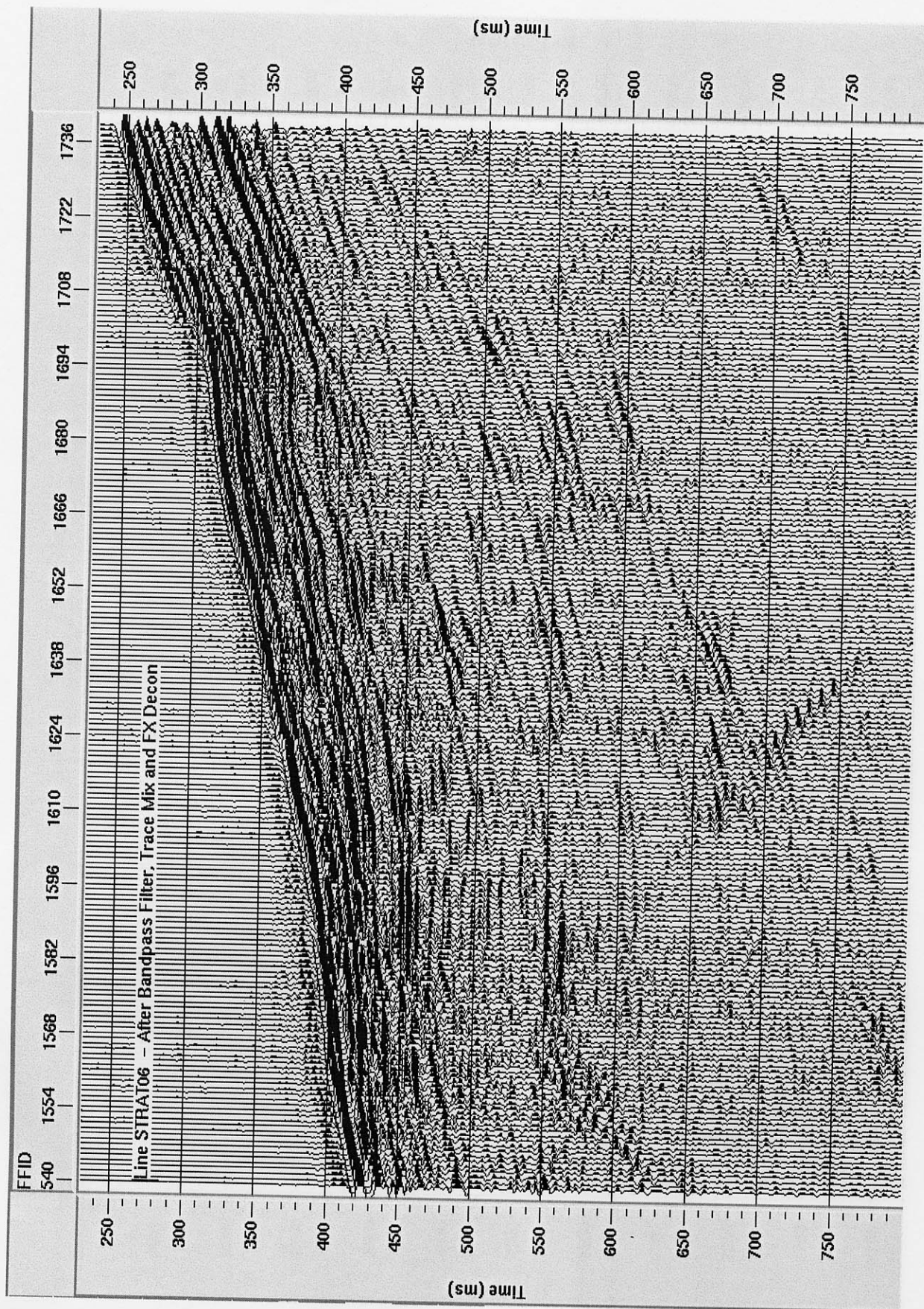


Figure 7



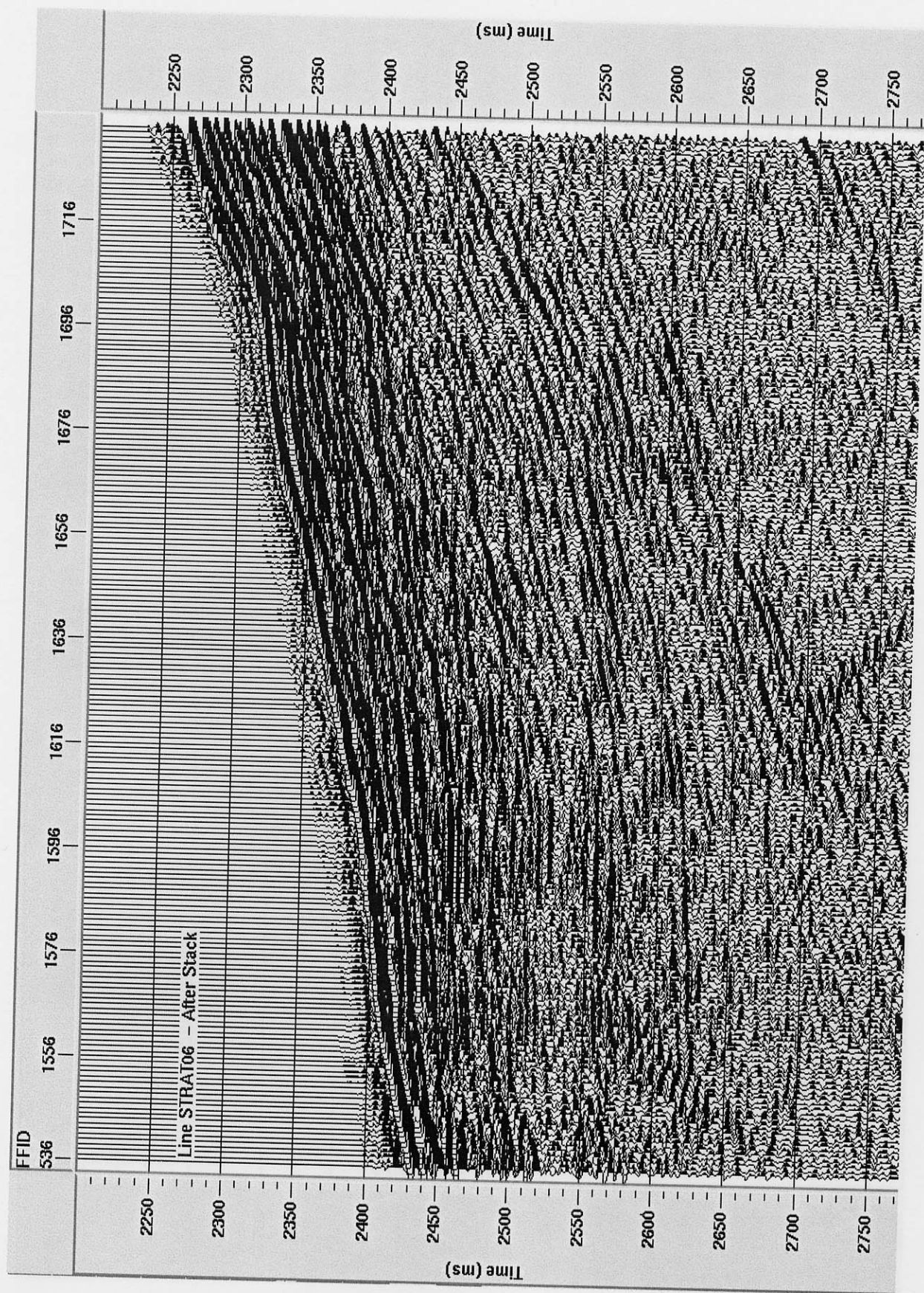


Figure 8

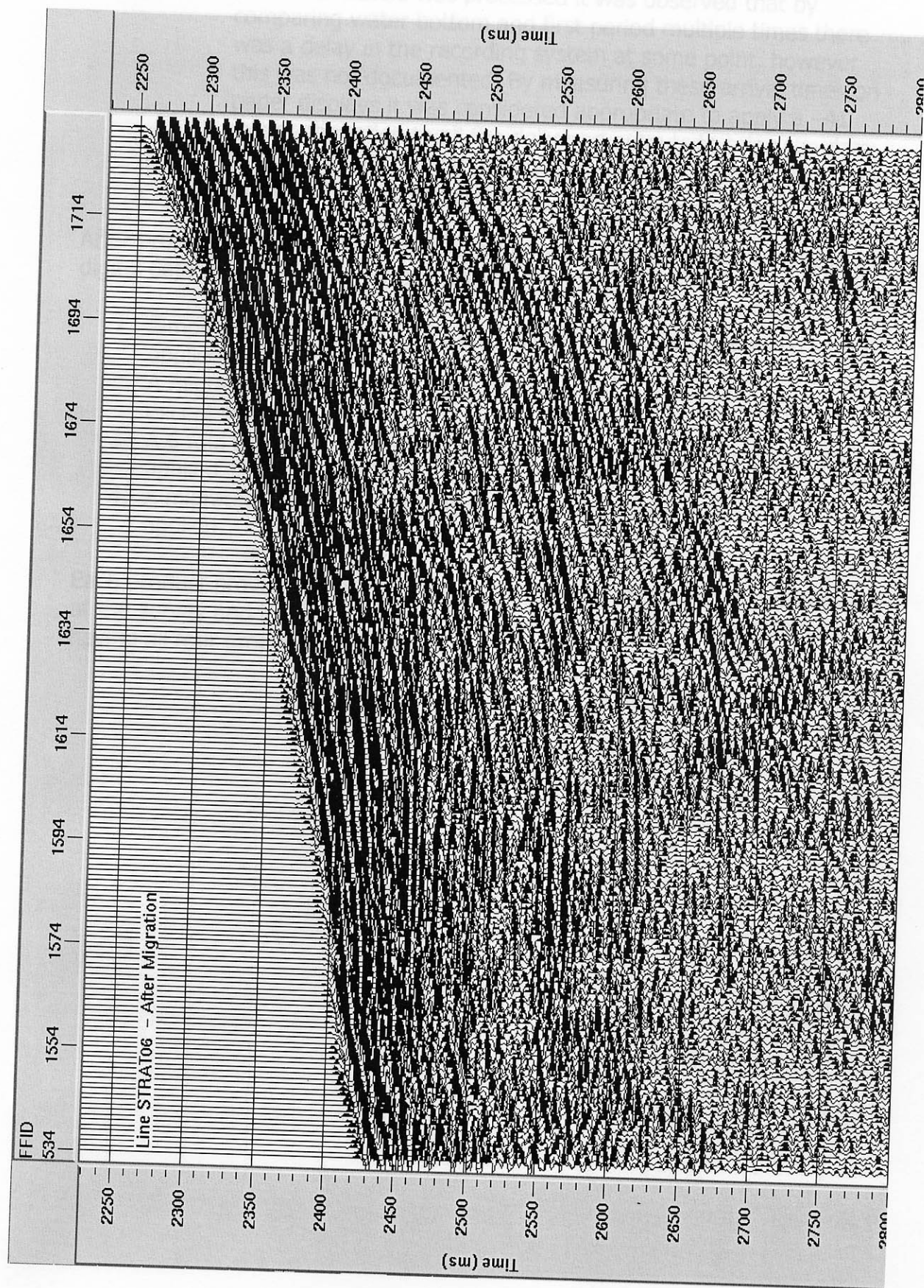


Figure 9