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Seismic Noise Attenuation from an Arctic Glacier Data

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ABSTRACT

Seismic data acquired from storglaciaren, situated next to Tarfala Valley was carefully processed with the right processing parameters. The acquisition of seismic data always comes with noise, these noise most times masked the signal in a way that it is difficult to delineate the seismic signal. Seismic noise attenuation is a key factor in understanding the subsurface geology. Adequate and proper noise attenuation methods can help to maximize the potential benefit and contribution of the seismic data in exploration and development. Noise that are not properly attenuated in one stage of data processing can find their way into the next stage of data processing, as such it is paramount that noise in any stage of data processing should be properly attenuated to levels where they can be expected to pose no further problems to most pre-stack processes. In this research noises that were not attenuated during prestack FK analysis were attenuated using poststack FK analysis.

Keywords: Signal Noise, FK analysis, Pre-stack. Post-stack, Stack, Migration

I. INTRODUCTION

Seismic data always consist of signal and noise component. What is considered as noise is relative and depends on what the data is used for at that stage of processing. Refracted energy can be seen as a seismic noise, but during static correction, the same refracted energy is seen as a signal. Any recorded energy which interferes with the desired signal is seen as noise. Seismic noise can be classified as background noise (i.e. wind, swell, noise from nearby production, or interference from nearby seismic acquisition), source-generated noise (direct and scattered waves or multiples), & instrument noise that can show up as coherent or incoherent energy in seismic gathers [1, 2].

The acquisition of seismic data always come with noise, these noise most time masked the signal in a way that it is difficult to delineate the seismic signal. Seismic noise attenuation is a key factor in understanding the subsurface geology. Adequate and proper noise attenuation methods help to maximize the potential benefit and contribution of the seismic data in exploration and development [3]. Dingus [3], the importance of the removal of seismic noise are as follows: attenuation of seismic noise allows all other signal processes flow to work more effectively, removal of noise is a key factor in preparing the data for pre-stack imaging, Proper attenuation of seismic noise provides the opportunity to track amplitude anomalies and stratigraphic objectives with confidence, and effective noise removal preserves the original amplitude and phase characteristics of the data, which enables the data to be used for advanced attribute work and inversion to better understand the reservoir. In the attenuation of seismic noise from the data, one must ensure that the underlying signals are not attenuated [4]. Seismic data can be acquired on land, marine, desert and on glacier, the data used in this research is acquired on a glacier. The aim of this research is to process the glacier data, so as to understand the subsurface of the glacier.

Geology of study area

The seismic data used for this study was acquired from storglaciaren, situated next to Tarfala Valley. However it has complex thermal regime with an internal warm base, and a cold surface layer, which results in a 100-200 m

wide cold based zone in the thin glacier snout [5]. Storglaciaren sits in a small valley in the Kebnekaise Massif of Northern Sweden which has been studied in some details since 1945 [6].

Data Acquisition

The seismic data was acquired using split spread method. The geophone line is 475 m long and 5 m spacing between geophones. Shots were taken at every 10 m along the survey line. The trace spacing is 5 m. The seismic source is hammer and plate, A 10 *Hz* geophone was used as the receiver. Figure 1 shows the acquisition layout of the survey line. The acquisition geometry of the data is shown in Table 1.

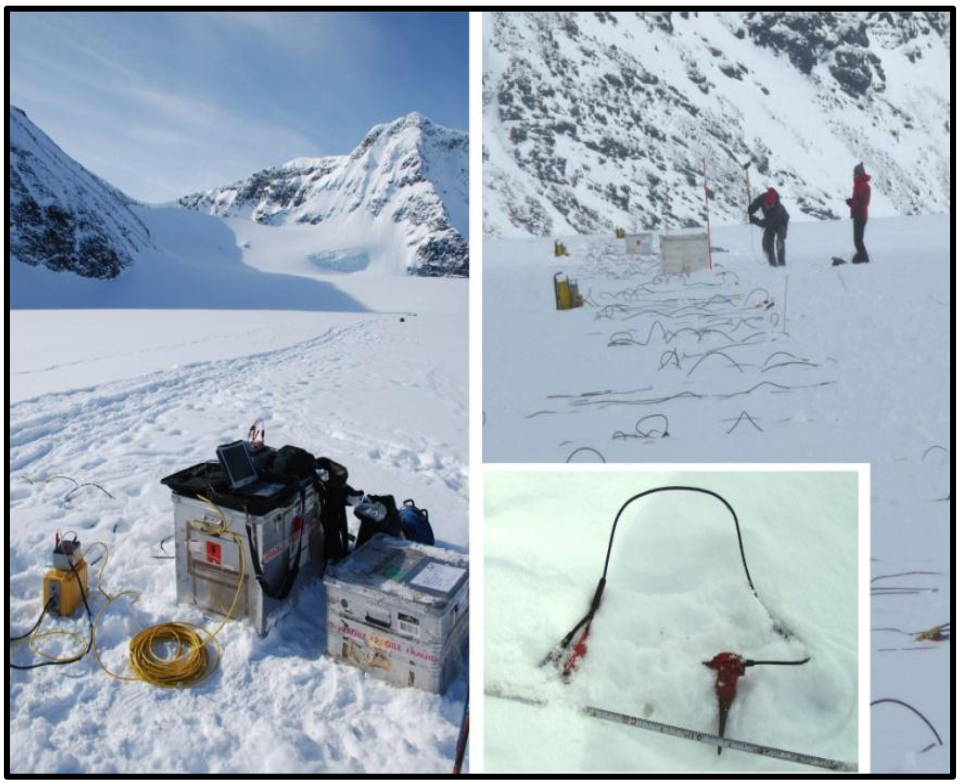

Fig.1: Acquisition layout of survey line (http://egugeolog.files.wordpress.com/2012/04/part-3-fig-3.jpg, 2012)

Table 1: Acquisition geometry of the data.

Method of Acquisition	Split spread Method
Geophone Spacing	5 m
Number of Geophone in per Group	1
Total number of Channel	96
Total number of Geophone	96
Sampling Interval	0.25 ms
Source	Hammer and Plate

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II. MATERIALS AND METHODS

The Software used in processing of the seismic data is ProMax. The work flow of the research is shown in Fig. 2.

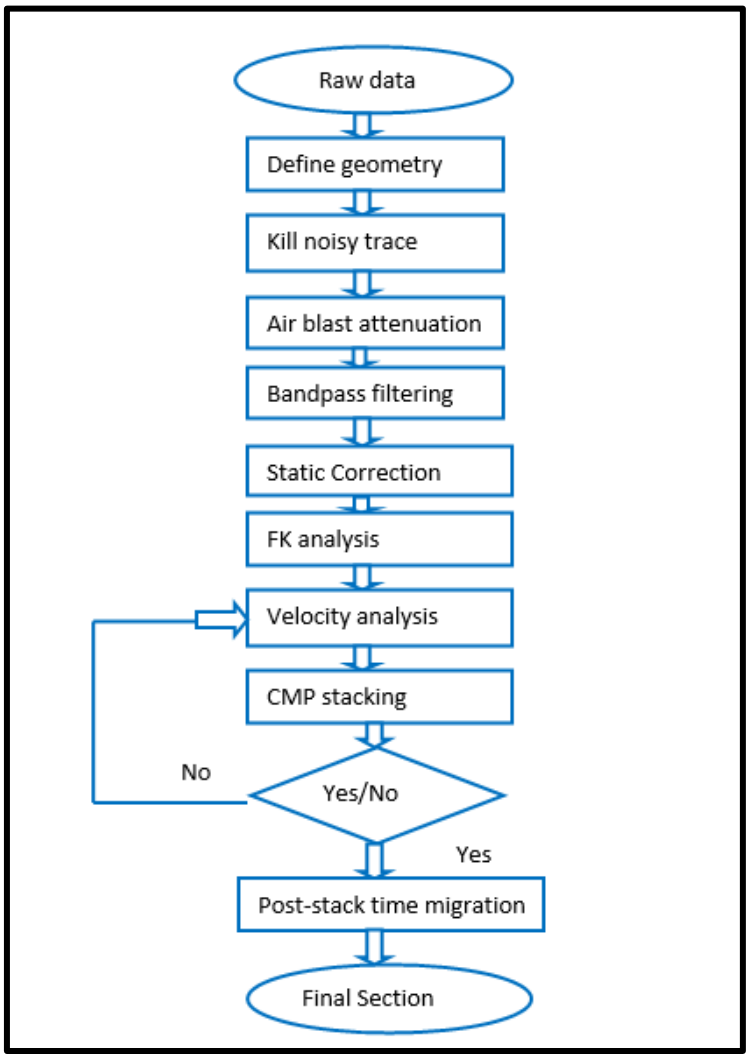

Fig.2: Processing flow of the data

Table 2: parameters used in attenuating air blast

AIR BLAST ATTENUATION	
Approximate Velocity of energy to be attenuated	320 ms^{-1}
Start time (ms) at zero offset	0
Type of energy attenuation	Attenuation
Automatically search for and detect noise?	No
Time gate width of air blast energy to attenuate	60 ms

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Figure 3 shows the raw data before attenuation of noise. Proper noise attenuation was carried out first by analysing the seismic data to determine regions that have bad traces or dead traces, these traces were killed or muted. In order to attenuate the air blast from the seismic data various parameter were tested. The parameters used in the attenuation of the air blast from ProMax software are shown in Table 2.

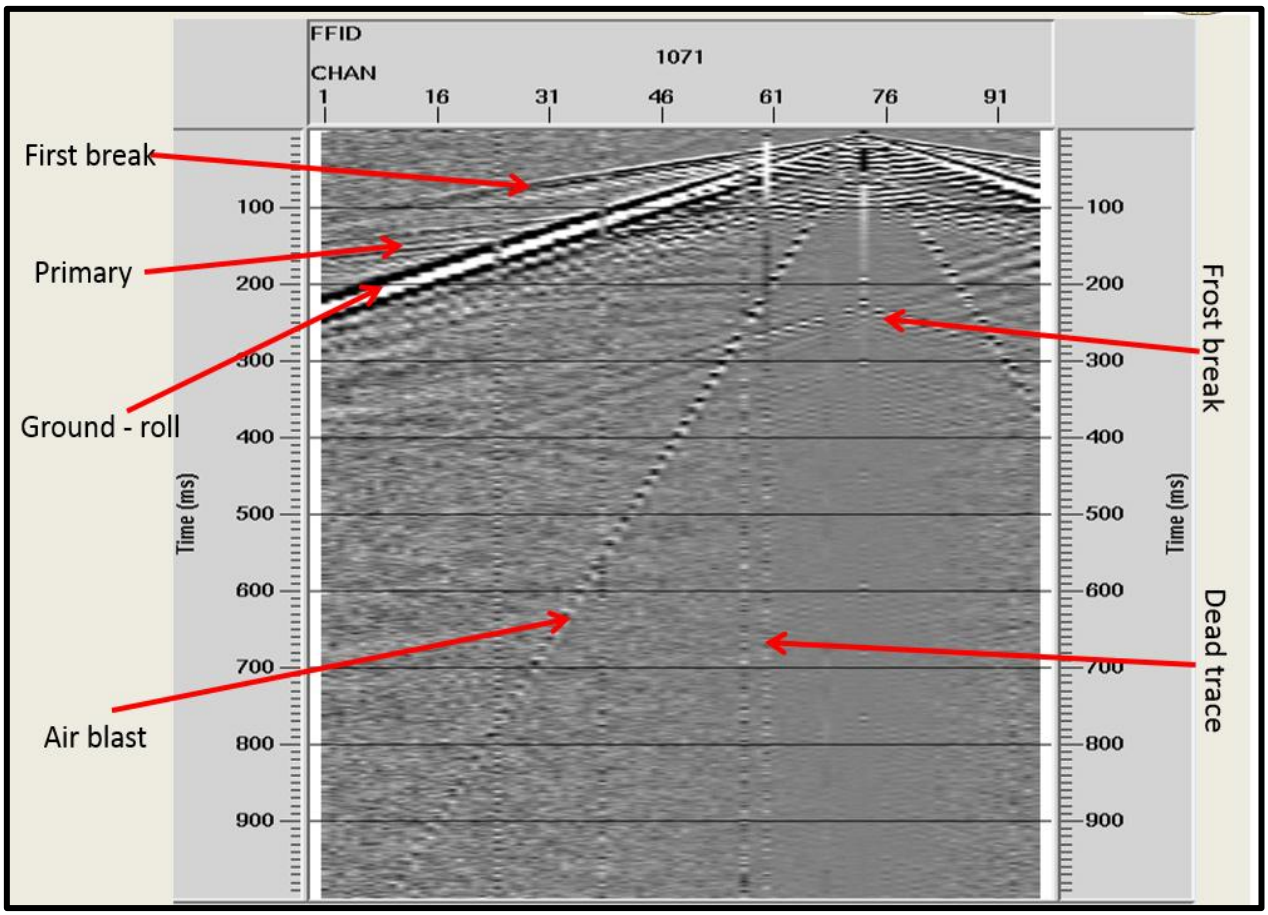

Fig. 3: Raw data before noise attenuation

After properly attenuating the noise from the data, the data was stacked and finally, migration was applied on the data. The effect of migration is to move dipping reflections to their true subsurface positions and collapses diffractions, thereby increasing spatial resolution and yielding a true seismic image of the subsurface (7).

III. RESULTS AND DISCUSSION

Figure 4a shows the data before the attenuation of air blast, in Fig. 4b the air blasts have been attenuated using the air blast attenuation parameter shown in Table 2. Looking at the red loop in Fig. 4b we can see that the air blast has been attenuated compared to the red loop in Fig. 4a.

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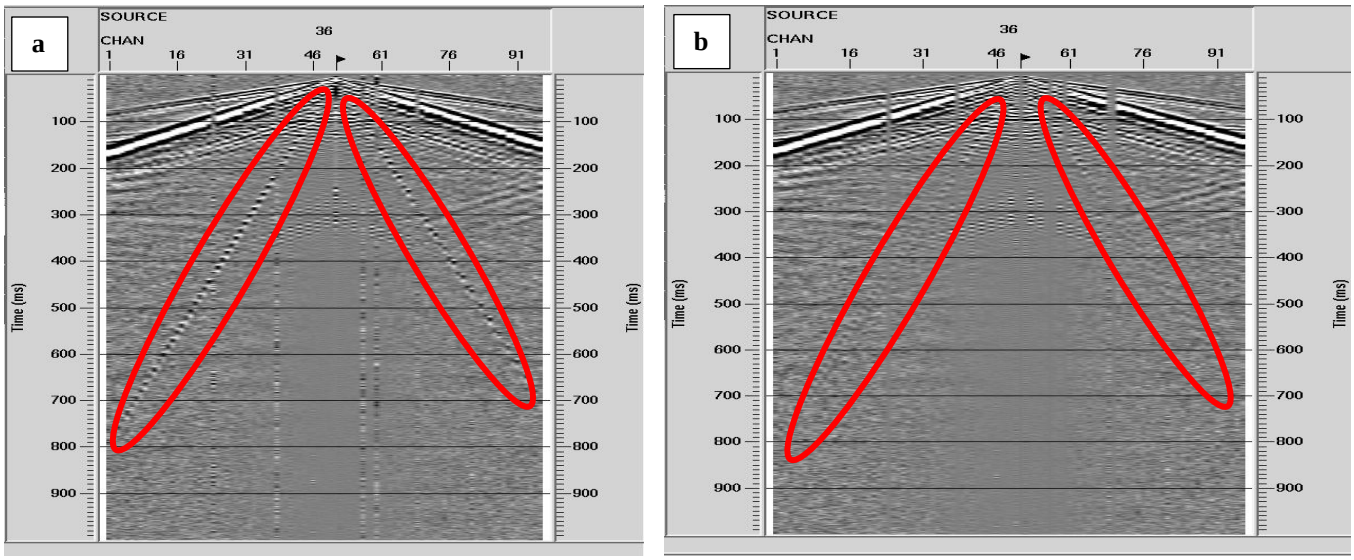

Fig. 4: Attenuation of air blast. (a) Before air blast attenuation. (b) After air blast attenuation. The air blasts noise have been attenuated.

The refracted energy was muted out as shown in Fig. 5, in Fig 5, red arrow indicates refracted energy. Band pass filter was applied to remove the ground roll from the data. In data processing Band-pass filtering is performed at various stages. If necessary, it can be performed before de-convolution to suppress remaining ground-roll energy and high frequency ambient noise that otherwise would contaminate signal autocorrelation [7]. The aim of band-pass filter is to remove high amplitude, low frequency and low velocity ground-roll from the recorded seismic data. As can be seen in Fig. 3, the amplitude of the ground is high.

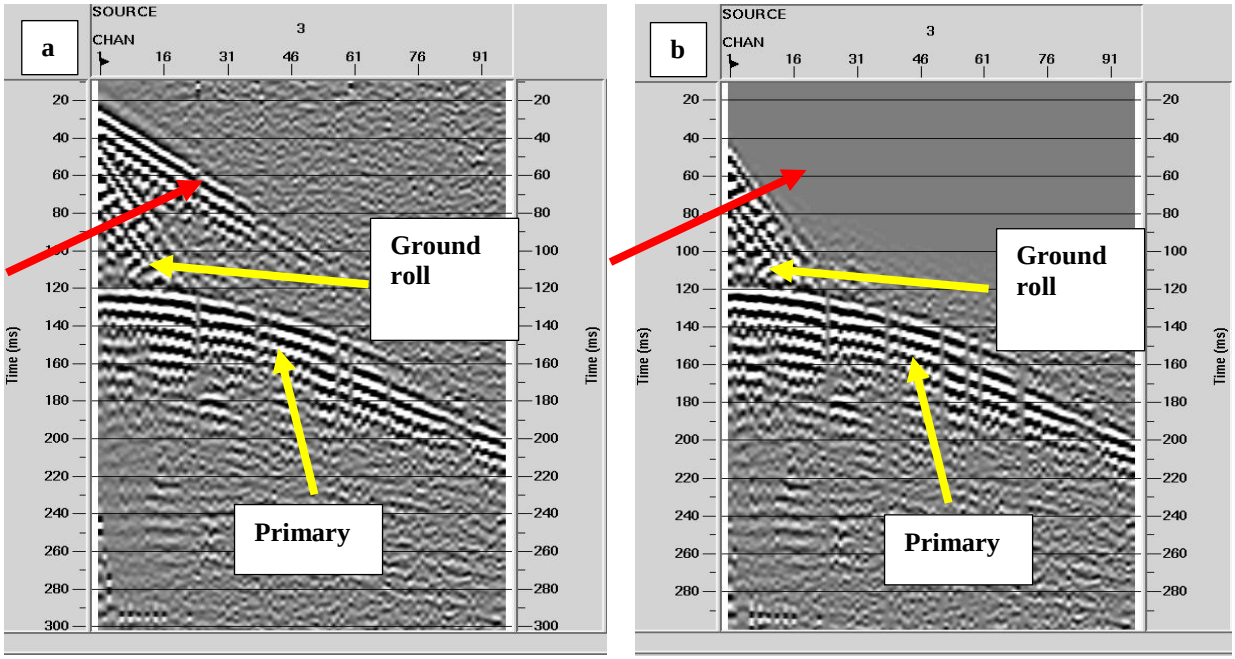

Fig. 5: Muting of refracted energy. (a) Before muting of refracted energy. (b) After muting of refracted energy.

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Various filters were designed to attenuate the high amplitude ground-roll from the seismic data. The acceptable filter used in attenuating the ground is (60-120-175-350) Hz. On the right image of Fig. 6, one can see the ground roll, after the application of band pass filter we can see that the ground rolls have been attenuated as shown in the left image of Fig. 6.

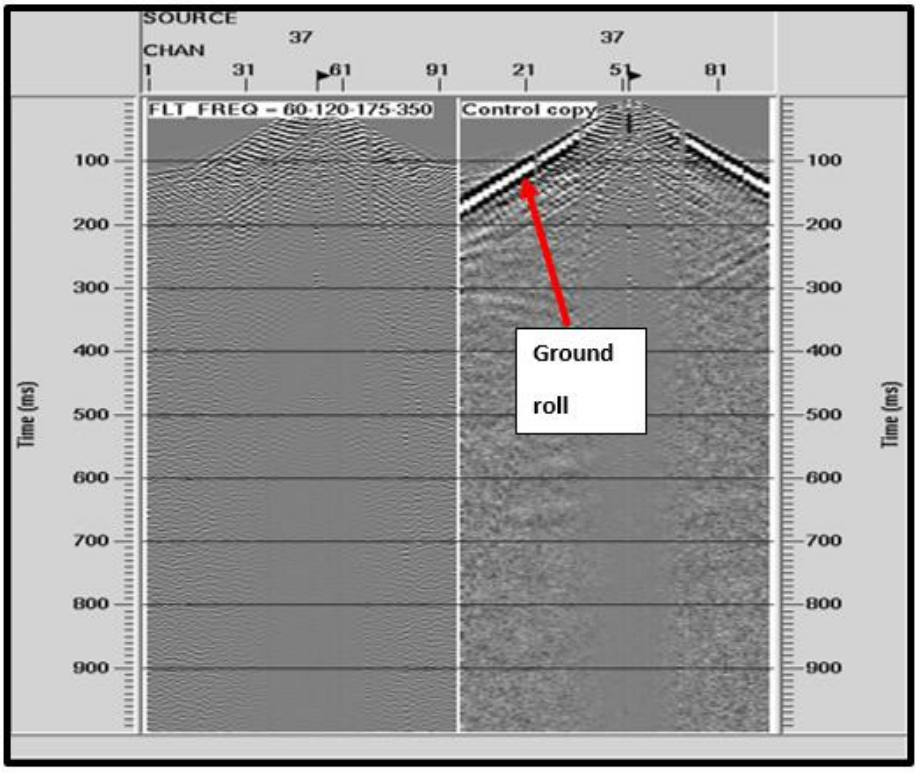

Fig. 6. Attenuation of ground roll using Band pass filter

Stacking is a multichannel filter mostly used to attenuate multiples and ground roll. It is also used in the reduction of the seismic data. Seismic data reduces in volume after stacking. Stacking a seismic data gives the geology of the sublayer, but it does not give the true position of the reflectors. In order to determine the true position of the sublayer, the section has to be migrated. Stacking compresses the offset dimension, thus reducing seismic data volume to the plane of zero-offset seismic section and increase the signal-to-noise (S/N) ratio [8].

Noise that are not properly attenuated in one stage of processing can find their way into the next stage of processing, Figure 7 shows the stacked section after NMO correction. Due to the effect of some noise not properly attenuated during pre-stack FK analysis stage, these noise can be seen in the red rectangular loop in Fig. 7. Post-stack FK analysis was applied on the stacked data. On the application of Post-stack FK analysis, the noise seen in the red rectangular loop in Fig. 7 were now properly attenuated given a much better image as can be seen in the display with the post-stack section in Fig. 8.

Migration moves dipping reflections to their true subsurface positions and collapses diffractions, thus increasing spatial resolution and yielding a seismic image of the subsurface [7]. Migration was applied on the post-stack FK

analysis section to enable the stack section to have the true picture of the geological structure of the subsurface. Migration was applied using the velocities that were picked in the velocity analysis process.

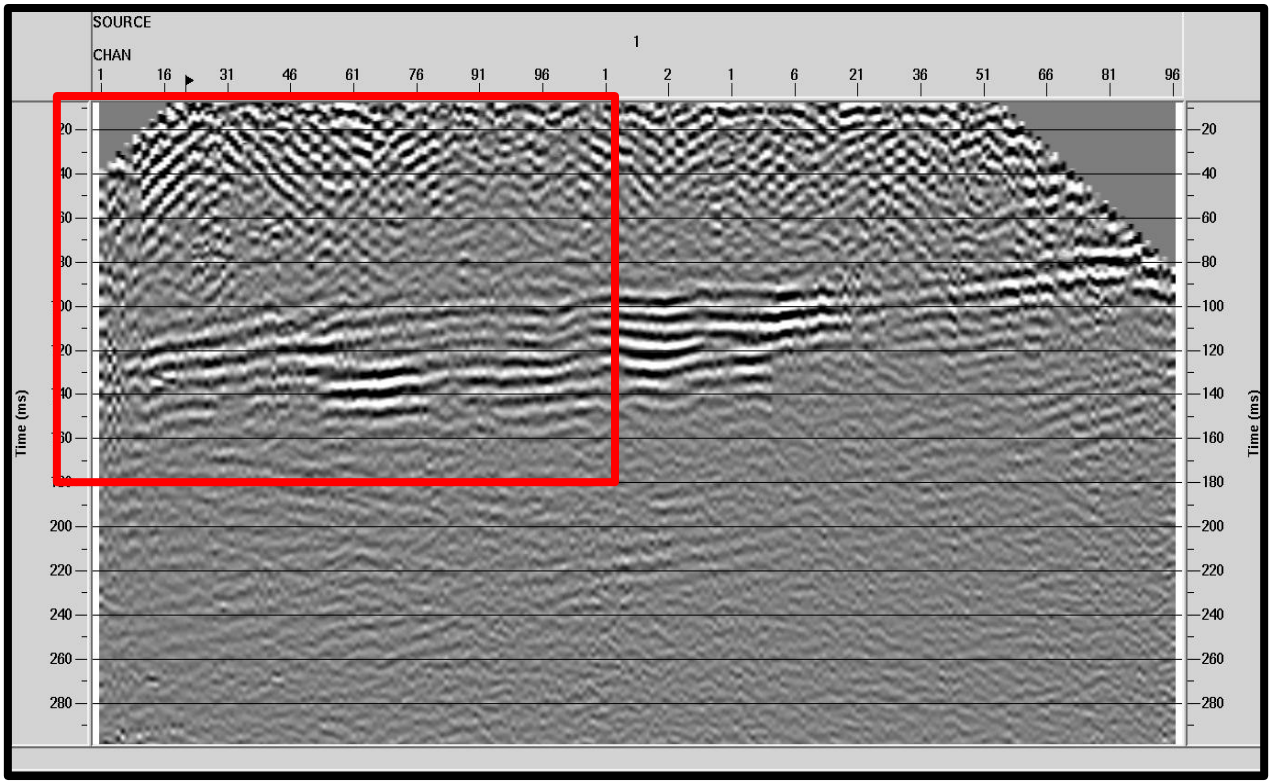

Fig. 7: Stacked section after NMO correction. Red rectangular loop shows the presence of noise.

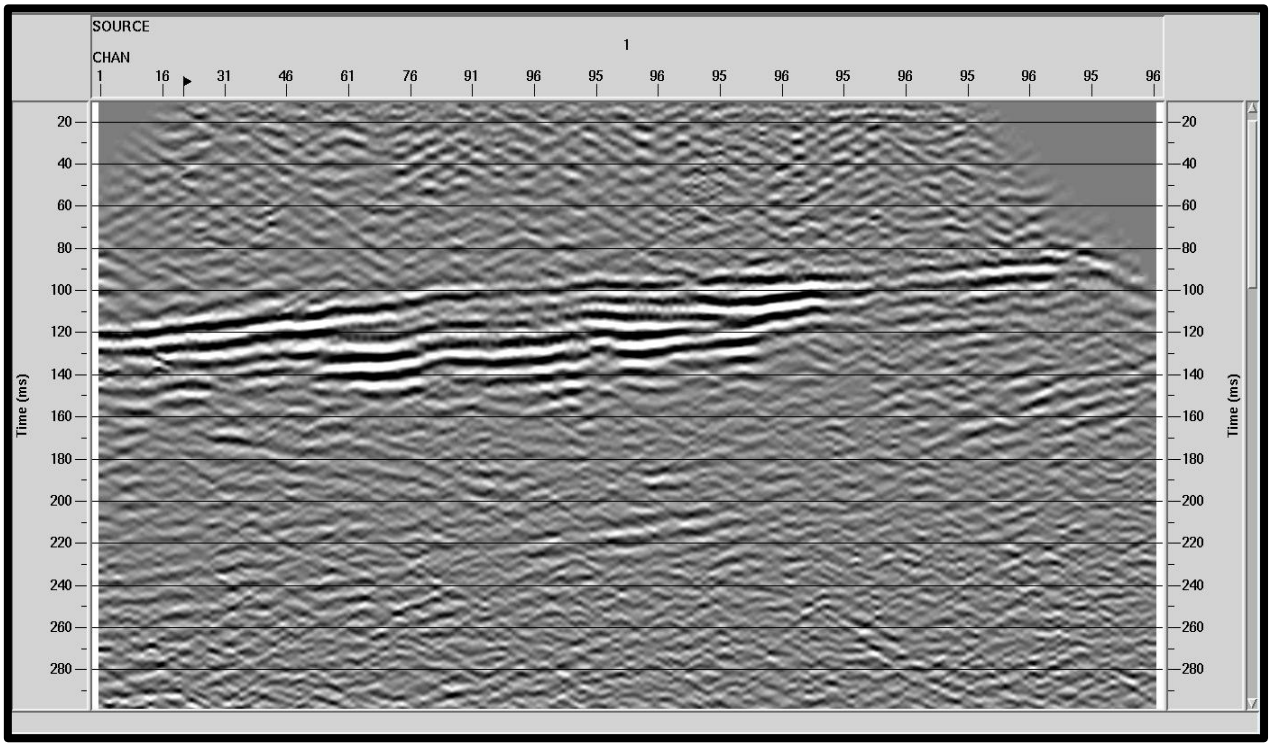

Fig. 8: Data showing the application of post-stack FK analysis.

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These velocities that were picked were used to collapse diffraction event in the data. Migration is generally based on the premise that all data elements represent either primary reflections or diffraction. Kirchhoff time migration was applied as the migration algorithm. Different migration apertures were tested to collapse the diffractions in the seismic data. The migration aperture parameter that were tested for migration are; 20 m, 50 m, 60 m, 70 m, 90 m, and 150 m. From these tested migration apertures, it was the 20 m Migration aperture that was selected as the accepted migration aperture since it produces more pronounce reflection than the other migration aperture. The migrated section is shown in Fig.9. The parameters used for the migration are shown in Table 2.

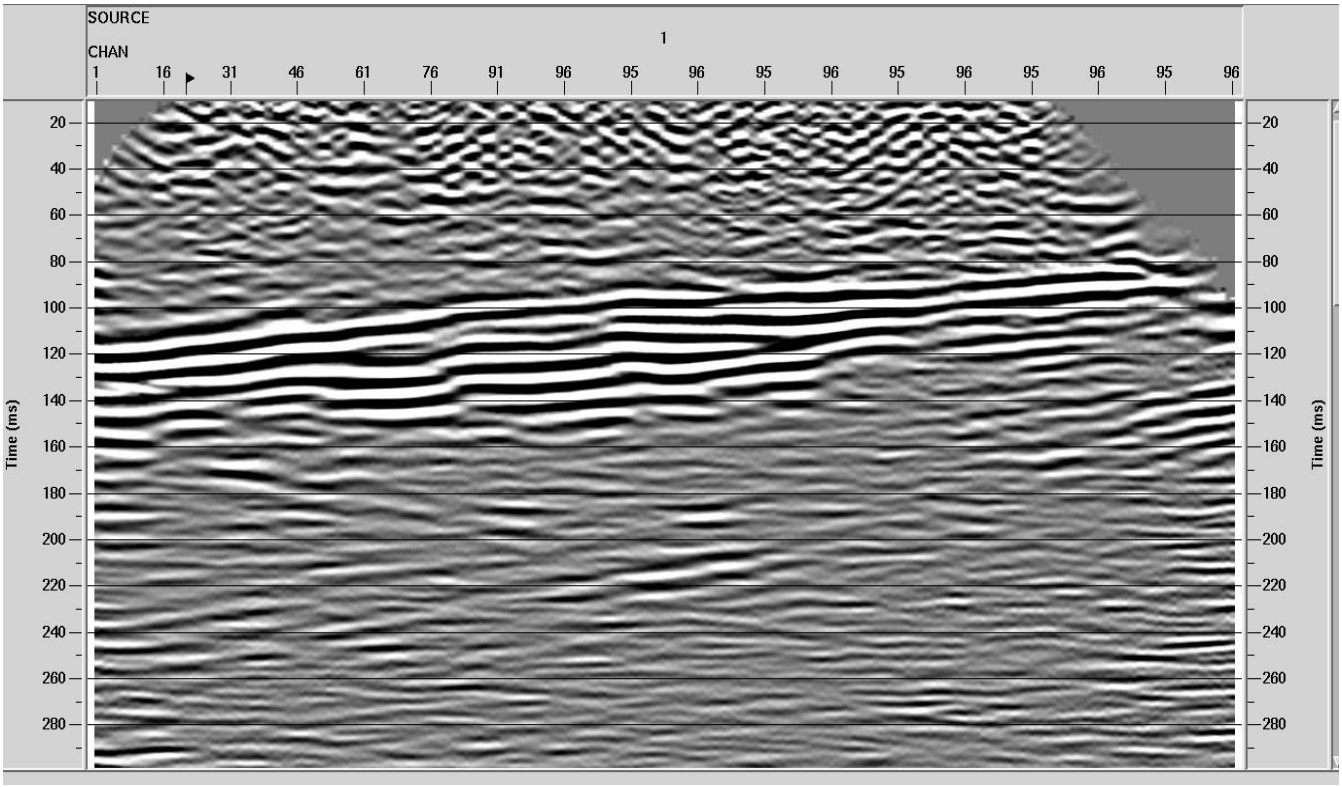

Fig. 9: Migration aperture of 20 m

Table 2: Parameter used for migration

Kirchhoff Time Mig.	?
CDP interval (feet or meters)	5.
Maximum frequency to migrate (in Hz)	350.
Migration aperture (feet or meters)	20.
Maximum dip to migrate	180.
Avoid spatial aliasing?	Yes No
Get RMS velocities from database?	Yes No
Select RMS vs.time velocity file	velocity analysis test
Change maximum memory usage?	Yes No
Change the default tapering?	Yes No
Re-apply trace mutes?	Yes No
Re-kill dead traces?	Yes No

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IV. CONCLUSION

Proper processing of seismic data can attenuate seismic noise of various type from the data. Noise free data can be achieved if the right processing parameter are used. From this research it can be observed that noise that are not properly attenuated in one stage of data processing can find their way into the next stage of data processing, as such it is paramount that noise in any stage of data processing should be attenuated to levels where they can be expected to pose no further problems to most pre-stack processes [4]. Using the right processing algorithm, the seismic imaging of the study area is being achieved.

V. ACKNOWLEDGEMENT

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