



Coherent Noise Attenuation Using AGORA Filter on 2D Seismic Data in East Diwaniya, South Eastern – Iraq

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Abstract

Coherent noise such as ground roll and guided wave is present in the seismic line DE21 (East Diwaniya south eastern Iraq) and it obscures seismic signal and degrades from the quality of data. To attenuate the coherent noise from the shot gather and the Stack of the seismic line, AGORA filter was applied in order to obtain the good signal as the hyperbola shape in shot gather and the reflectors will be clearly to interpret it later. It has given good results and the coherent noise was attenuated in high ratio on all the line. The spectrum analysis is confirmed the effectiveness of AGORA filter to attenuate the coherent noise.

Keywords: Coherent Noise, Attenuation, Reduction, AGORA filter, seismic data, Iraq.

توهين الضوضاء باستخدام مرشح (AGORA) على المعلومات الزلزالية ثنائيه الابعاد في شرق الديوانيه جنوب شرق العراق

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الخلاصة

لوحظ ان الضوضاء المتجانسة مثل الموجات السطحية والموجات الموجهة موجودة في الخط الزلزالي DE21 (شرق الديوانية- جنوب غربي العراق) وهذا الضوضاء يسبب في حجب الاشارات الزلزاليه ويقلل من جودة البيانات. ولغرض توهين الضوضاء المتجانسه من تجمع المصدر النقطي والمعلومات المنضدة للخط الزلزالي جرى تطبيق مرشح AGORA لاجل الحصول على اشارة جيدة على شكل القطع الزائد في تجمع المصدر كما ان العواكس تصبح اكثر وضوحا لاجل تفسيرها لاحقا. وقد اعطت هذه الدراسة نتائج جيدة وتم توهين الضوضاء المتجانسه بنسبة عالية على طول الخط الزلزالي وتؤكد نتائج تحليل الطيف فعالية مرشح AGORA لتوهين الضوضاء المتجانسة

Introduction

In the exploration for oil and gas the seismic data usually present a low signal to noise ratio due to the presence of coherent noise generated by surface waves [1]. Coherent noise is a persistent problem in seismic imaging, and a number of techniques have been developed to attenuate it. Attenuation of coherent noise is the first step that faced inland data processing[2].

The coherent noise which may appear on a seismic record includes surface-waves (ground roll), air-waves, guided wave, body waves (direct-, refracted-, and multiples). These noises and interferences are generated from the source seismic-energy [3].

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One of the most significant challenges in processing of seismic data is to filter different types of noises. Ground roll is one of the main types of coherent noise inland seismic data. It has the significant characteristics of relatively low velocity, low frequency, high amplitude and strong energy[4,5]

Guided waves are reflected multiples that travel in layers separated from the surrounding medium by high- impedance contrasts and therefore are a common phenomenon of wave propagation in layered media. In exploration seismology, guided wave is often observed in surface seismic data[6]. Many conventional methods have been developed to attenuate these noises, the conventional methods can be divided into two groups. The first one can be summarized to filter method which is based on suppression of undesired parts of recorded data in the spectral domain, including high-pass and band pass filtering, f-k filtering [7-9] and the adaptive ground-roll attenuation method [10,11].

The adaptive ground-roll attenuation method (AGORA) can be applied to attenuate ground roll in different domains, such as cross-spread or common shot/ receiver domain depending upon the data needs. This data driven technique adapt to the changing noise characteristics and subtracts ground roll adaptively while preserving primary amplitudes[12].

Study Area and Data Available

The study area represents the eastern region of Diwaniya which located in the south – east of Iraq within the province of Qadisiyah along the Euphrates River and between the cities of Kut in the north and Samawa to the south (Figure-1) and can be determined by the coordinates in (U. T. M.) system in Table-1.

The area includes agricultural lands with abundant dense sand dunes. There are always flooded areas such as (victory evaporator) located in the south- eastern part of the region , for the most lines to enter Hor Aldlameg the area in general flat and rising at sea level ranges from (7-20) m[13]

Table 1- Coordinates of the study area, after Oil Exploration Company[13].

Point	Easting	Northing
A	556000	3498000
B	588000	3532000
C	540000	3568000
D	492000	3524000
E	508000	3502000
F	526000	3516000

The available data for this study include one seismic line of 2D seismic surveys of eastern Diwaniya. This line is part of 2D seismic survey achieved in 1991 by (O.E.C.). In current study this line will be reprocessed with modern methods on the Geovation system.

The seismic line is DE21; the length is 85.26 km. towards NW-SE while its field parameters are: source type is dynamite, No. of Channel are 96, coverage is 2400%, sampling rate is 2 ms, recording length is 5 sec., trace spacing is 70m and the offset is 280m.

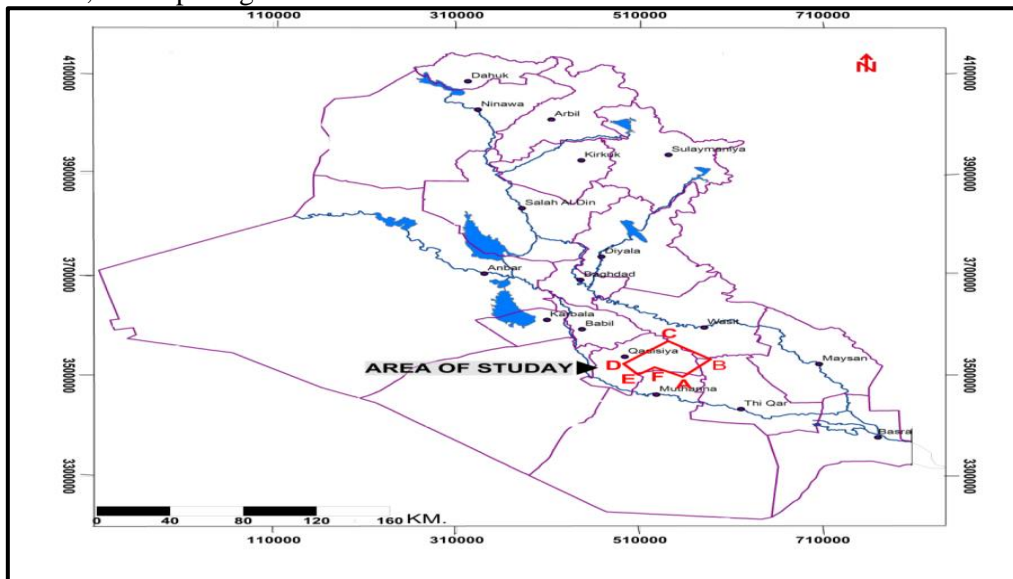


Figure 1- the geographical location of the study area.

Theoretical Background

In each sub-bands, signal (S) is modeled as hyperbolic events whose trajectories were described by stacking velocity (V) as given in equation 1. The ground roll (GR) is modeled as a series of dispersive linear events, each distinguished by group and phase velocities as given by equation 2[14].

$$S^{j,k} = \exp\{if\{sqrt(T_j^2 + X_k^2/V_j^2)\}\}..... (1)$$

$$GR^{j,k} = \exp[i\{(f^\circ/vp_j) + (f - f^\circ)/vg_j\}X_k]..... (2)$$

For a ^jth event T₀ is the zero offset travel time, X_k is the true shot receiver distance, f₀ is the central frequency of the wave and vp_j and vg_j are the phase and group velocities extracted from the input data. These events form the components of a matrix(A)with column and row indices j and k. the input data in the frequency domain can be represented by a matrix(D)as described by equation 3[14]. A is the matrix that contain hyperbolic and dispersive linear events. W is a vector containing an unknown wavelet corresponding to the signal and ground roll plus some percentage of random noise N.

$$D = A * W + N (3)$$

A least square iterative approach is used to adapt this model to input data and ground roll is subtracted[12].

Adaptive Ground-roll Attenuation (AGORA)

AGORA is a data-driven approach performing a 2D/3D adaptive ground roll and guided waves attenuation even with an irregular offsets distribution [15].

Before running AGORA, spikes, bursts, and noises must be removed. Moreover, bad coupling effects between neighboring receivers in a given shot or receiver also affect the quality of the ground roll attenuation, especially the adaptive process. The AGORA process can be described by the following main steps [16]:

- 1- Extractions of the ground roll characteristics via a frequency-velocity phase diagram.
- 2- Wavelet domain. Wavelet filter banks allow a multi-resolution approach with a split of the input data in several frequency-wave number sub-panels using a "highly" reversible wavelet transform.
- 3- Modeling in the FX domain of aliased and dispersive surface waves is done for each sub-panel using the most adapted set of parameters derived from the data itself via the frequency-phase velocity panel.
- 4- Back-scattering in the FX domain is removed via a fan-rejected filter approach that can be due to aliased ground roll not removed by the modeling or backscattering generated by the near-surface or buried heterogeneities.
- 5- A multi-thread approach is available, which allows AGORA processes to be submitted using several cores per node.

Data processing and Results

Processing has been carried out using Geovation software of CGG AGORA module. The principle of AGORA depends on the velocity to determine the range of velocity, the slope should be computed by (ΔT/ΔX), where (T) is time and (X) is offset, the trace spacing value should be known in this computing. The static correction improve the hyperbola shape of the signal and will remove the overlapping with coherent noise, while the NMO remove the effects of the offset, both of them will be calculated and removed inside the AGORA procedure. In AGORA, several parameters are tested to de-noising the ground roll and guided waves in the seismic line of the current study. The parameters which applied are listed in Table-2

Table 2-illustrates the parameters of the module AGORA.

Parameters	Values
Min. frequency/ FMIN	2 Hz
Max. frequency/ FMAX	20 Hz
Min. ground roll velocity/ VG MIN	100 m/s
Max. ground roll velocity/ VG MAX	3000 m/s
Min. phase velocity	500 m/s
Max. phase velocity	5000 m/s
Ave. distance between receiver	70 m

The seismic line DE21 in shot gathers contains coherent noise (ground roll and guided wave) as pointed (red color) in Figure-(2A). The effect of applying AGORA module and its result depends on test of several parameters. For example when values of frequency range (2-18) Hz., velocity range (100-2500) m/s, also phase velocity (600-4500) m/s., were tested these tests didn't give beneficial outcome. So many other values were tested; the better tested values which give excellent consequence are shown in Table-2, were applied for de-noising ground roll. While when the AGORA module was applied for de-noising guided waves it also has subjected to many tests such as frequency range (4-16) Hz., velocity range (1000-2500) m/sec., phase velocity range (400-4600) m/s, as in the Table-(2). These tests were applied for shot gathers and stacked for the seismic line which gave better results. The hyperbola of the signal is improved and became more obvious as shown in the Figure-(2B) for the shot gathers. While Figure-(2C) represents the coherent noise which is removed.

AGORA module was applied on the stack data of the seismic lines DE21, it has effectively de-noised coherent noise and the reflection events become more clarity after coherent noise has been attenuated, also the reflectors seem to be with less distortion and have good continuity (Figure-3).

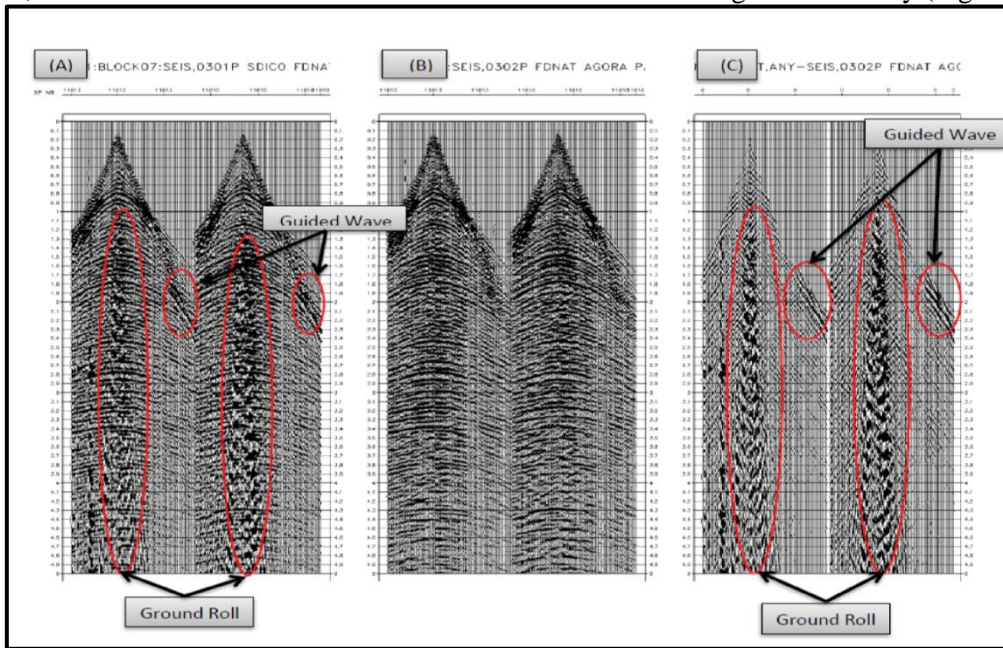


Figure 2- (A) Input Shots before AGORA (B) Output Shots after AGORA (C) the removed coherent noises in line DE21.

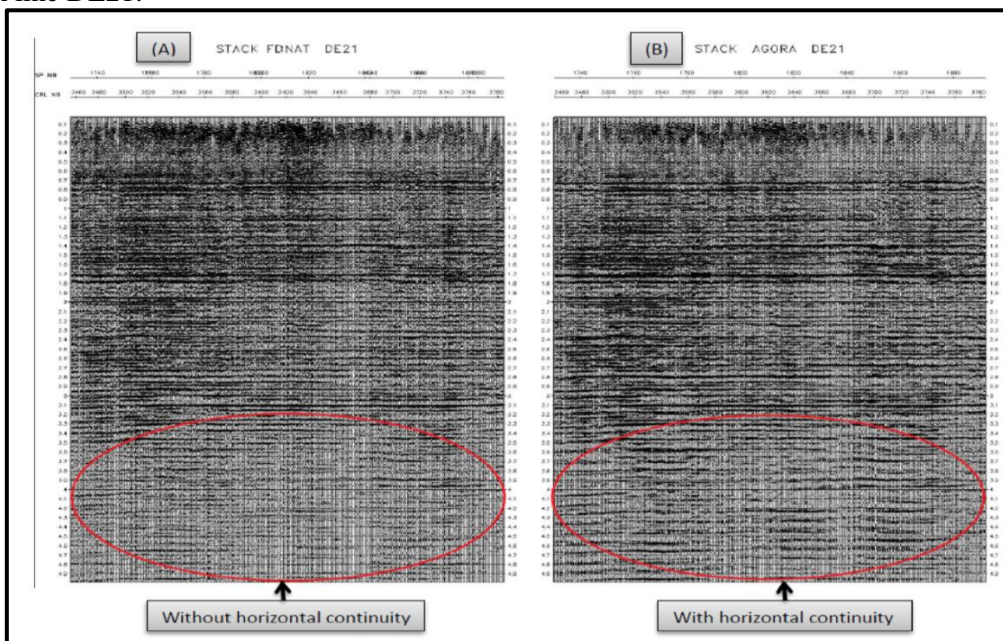


Figure 3- (A) Input stacked before AGORA (B) Output stacked after AGORA for seismic line DE21.

The spectrum analysis for coherent noise to the line DE21 for FDNAT (Figure-4) shows spectrum line (green line) with higher amplitude for coherent noise within the frequency range (0-10) Hz comparing with amplitude of the signal within the same window of frequency. After applying of AGORA module (Figure-5) the signal to noise ratio is increased and amplitude of the signal is increased comparing with the amplitude of the noise within the window of frequency (0-40) Hz. These results confirm the usefulness of AGORA in seismic data processing in current study.

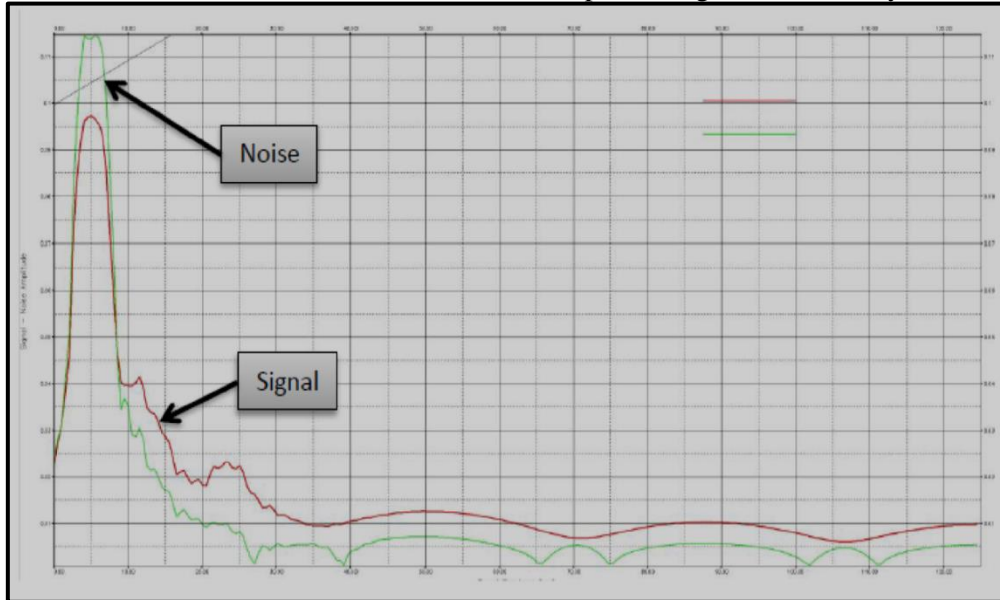


Figure 4- illustrate the spectrum analysis of the FDNAT signal to noise ratio for the seismic line DE21.

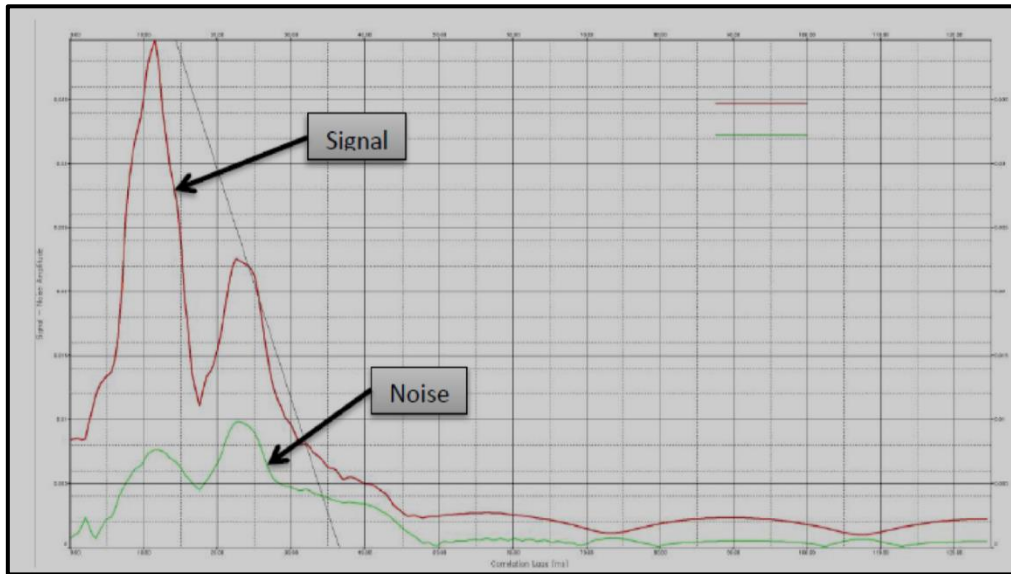


Figure 5- spectrum analysis after applying the AGORA in the seismic line DE21

Conclusions

The AGORA module was used for attenuation of seismic ground roll and guided wave in 2D seismic records. The results illustrate the ability of AGORA module to successfully suppress scattered ground roll and guided wave energies, allowing for the further processing of better quality data. Also the module AGORA was applied on the shot gather, it is highly de-noising the ground roll and guided wave but the outcome of AGORA for de-noising ground-roll is better than that of de-noising of guided wave in current study. Finally, an important benefit of this module is its application in different domains depending upon the acquisition geometry and data needs.

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