ISSN: 0067-2904
GIF: 0.851

Application of the Elevation and Residual Static Correction methods on a selected Seismic data of West Luhais area in the South of Iraq

Khalid. S. Al Mukhtar, Nabhan Nafie Aswad*
Department of Geology, College of Science, University of Baghdad, Baghdad, Iraq

Abstract

The present study deals with processing of one seismic line (2WL2) with a length of (37km) for (2D) seismic data of west Luhais area that is located within the administrative borders of the province of Muthanna in south of Iraq. The quality of the recorded data of this line is in general weak due to the effect of noise mainly. The study was made up in oil Exploration Company by utilizing OMEGA software which consists of a great number of the processing programs. The elevation static correction and residual static correction were applied on the studied line and the final section were resulted after completing the treatment processes that proceed followed of the static correction process and the result of elevation static correcting was good and accept in department of interpretation.

Keywords: elevation static correction, residual static correction.

تطبيق طريقة التصحيح الثابت للتضاريس والتصحيح الثابت المتبقي على بيانات زلزالية مختارة من منطقة غرب اللحيس في جنوب العراق

خالد شهاب المختار، نبهان نافع اسود*
قسم علم الارض، كلية العلوم ، جامعة بغداد، بغداد، العراق

الخلاصة

ان هذا البحث يتعلق بالمعالجه الزلزالية لخط زلزالي واحد (2wl2) وبطول 37كم من بيانات الانعكاس الزلزالي ثنائي الابعاد لمنطقة غرب اللحيس الواقعه ضمن الحدود الادارية لمحافظه المثنى في جنوب العراق حيث كانت نوعية البيانات للخط غير جيدة وكانت الاشارة الزلزالية ضعيفة وتحتوي البيانات على ضوضاء بنسبه عالية. اجريت الدراسة ضمن قسم المعالجة في شركة الاستكشافات النفطية بأستخدام منظومة الاوميكا التي تحتوي على عدد كبير من البرامج التي تخص عمليات المعالجة. تم تطبيق التصحيح الثابت للتضاريس والتصحيح الثابت المتبقي و تم الحصول على المقاطع النهائية لانواع التصحيح الثابت (تصحيح الثابت للتضاريس و التصحيح الثابت المتبقي) بعد اكمال عمليات المعالجة التي سبقت وتلت عملية التصحيح الثابت و كانت نتيجة تصحيح التضاريس جيدة وتم اعتمادها في قسم التفاسير.

1.Introduction:

Static correction is often called statics, a bulk shift of a seismic trace in time during seismic Processing [1].Static corrections, unlike many specialized geophysical subjects, are essential to all three key sub disciplines: data acquisition, data processing, and interpretation. It is necessary to corrected reflection time for predictable irregularities not associated with structure at depths of interest. One obvious source of such irregularity is surface elevation. The study area (west luhais) is located in southeastern Iraq within the administrative borders of the province of Muthanna and it is located50 (km) south Nasiriya city and away from the Saudi-Kuwait boundaries about100 (km). Linked with the Nasiriya- Besah desert [2].

*Email: Nabhan567@ yahoo.com

The topography of the area is characterized by steep surface in the region to the north and north-east and interspersed with valleys and highlands stretching towards the north-south and northeast-southern**.** The northern and southern-eastern areas are more complex than the other parts of the studied area from the topography point of view. Field report indicates that seismic partlyNo.3 carried out a deep hole velocities survey [3] the area is characterized by the presence of several sand dunes in the parts of the region, especially near Besah. The altitude of these dunes is ranged between (100-160 m) above sea level, the other parts of area are covered by gravel [2**].** Most of the surface area is covered by modern sediments which are consisting of soft sand and gravel smooth (sediments of the Dibdibba Formation to modern Miocene - Paleocene). These sediments cover western part of the region**.** The eastern part of the region is covered by sandy limestone and clastic rocks which is mostly composed of sand and mud (sediments of Fatha Formation and Ghara Formation to modern Miocene) [4]**.** Due to the lack of drilled wells in west Luhais area we are obligated to use data of the drilled wells present in the surrounding areas. These wells Khaddar Almaa (Kl) which is located to the south-east of the area and Abu Khema (K1), to the south of the region . The proposed lithology sequences at the site Abu Khema (K1) can be considered as a model type for subsurface geological formations that exist. The most important of types rocks that are present in the lithological column of well Abu Khema (K1) where of layers shale, sand and evaporates and limestone ,dolomite that of modern to cretaceous and tertiary period**.** West Luhais area lies structurally within Salman zone of stable shelf according to structural map of Iraq prepared by the Established Public Geological survey and Investigation of the Metal in 1984**.** The most conspicuous structure in the Salman zone has a strike in (NW-SE) direction [5].

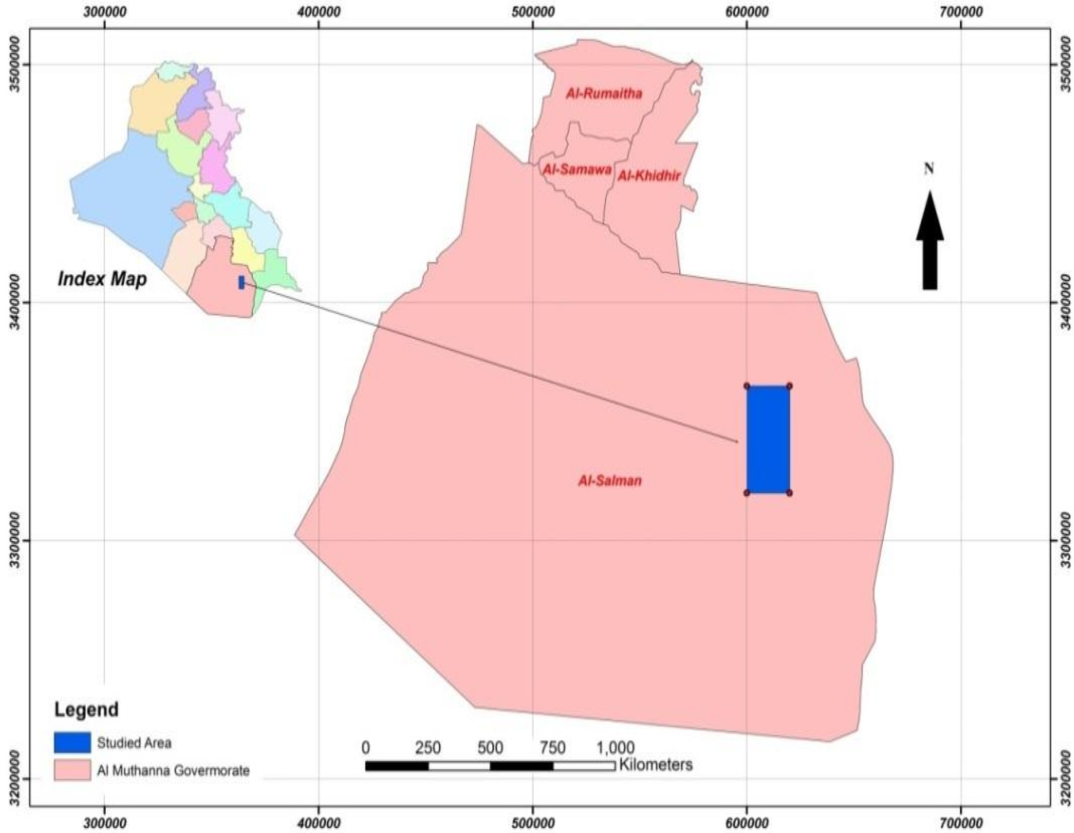

Figure 1- Map shows the location of the study area.

2. Theoretical Back ground:

Two types of static corrections are concerned in the actual study which is Elevation static correction and Residual static correction.

A- Elevation static correction

Elevation statics involve the computation and removal of the effect of different source and receive elevations. This involves a theoretical displacement of the source and receiver to a common datum, usually below the elevation of the lowest source or receiver. For this reason we need a replacement velocity (Vr) for the material between the datum and the source or receiver. The replacement velocity is either assumed from prior knowledge of the area or can be estimated from uphole times or direct arrivals. This correction (**T_D**) is computed by using the data values of the replacement velocity, elevations of receivers and shot points and datum plane [6]. The utilized formula is:

$$\mathbf{T_D = [(E_S - Z_S - E_D) + (E_R - Z_R - E_D)]/Vr,} \quad \textbf{(1)}$$

As shown in Figure-2 the symbols are clarified as follows:
E_S: ground elevation at shot location (from mean sea level),
Z_S: depth of shot (= 0 for a surface source),
E_R: ground elevation at receiver location (from mean sea level),
Z_R: depth of receiver (= 0 for a surface geophone), and
E_D: datum elevation (from mean sea level).

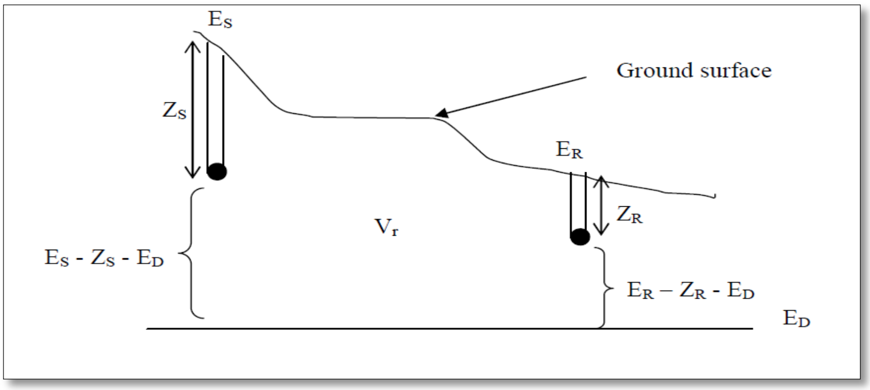

Figure 2- Simple model illustrating the symbols used in static correction computation.

Elevation statics are commonly used during the processing of seismic data, especially in the areas with rapid velocity variations in lateral direction **[**7-11].

B- Residual static correction

The residual static corrections are time shifts applied to traces in order to compensate for time delays and the statics model is a function of time and space [12-14]. Residual static corrections are defined as a subset of the static corrections [15]. Data-smoothing statics methods assume that patterns of irregularities which most events have in common result from near-surface variations and hence static correction trace shifts should be applied to minimize those irregularities. [12] Indicates that the concept of static correction is the assumption that a simple time shift of an entire seismic trace will yield the seismic records which would have been observed if the geophones had been displaced vertically downward to a reference datum. The time shift approximation means that static corrections are surface-consistent and independent of reflection times and trace offsets.

3. Acquisition and processing of data

According to Iraqi Oil Exploration Company plan proposed for the year 2014, a 2D Survey was conducted for the west Luhais area. The project program was carried out by the fourth seismic survey crew in (17/07/2014). The program consists of two groups of lines, the first one of (24) lines having a length equal to (32 km) for each line, then a supplementary addition of 5 km added to each line from both sides, and inter distance between each 2 successive lines is equal (2 km).The other group is composed of (6) lines which are perpendicular to the first group, having (58 km) length , also (5 km) from both sides was added and the inter distance between each 2 successive lines is equal to (4 km).The source energy used in the survey was(vibrioseis) and the number of receivers are equal to(200) in each line. The type of spread was symmetrical spread, recording time was (6) second using a sample rate of (2) milliseconds while the used datum plane is sea level. Due to the arises of some difficulties in some Iraqi areas in the computation of static correction, the Oil Exploration Companies (O.E.C) has suggested to make a study in West Luhais area. The present study attempts to solve the problems faced the interpreter during the computation process of the static correction. The proposed solution of the problem is made up through the study of the followings:

1. Study the effects of topography.
2. Study effects of the change in the low velocity layer thickness on the time of the reflected waves.

3. Analysis of all the expected cases in the computation of shot point and geophone corrections. This is followed by computation of field static correction to remove the effect of low velocity layer.
4. Using of residual static correction during the processing steps.

For this purpose, O.E.C provides the material of one line (2WL2) located in Luhais area to work in this subject. The seismic data processing for the line is achieved in the processing center in O.EC, according to the traditional processing sequence using omega system. Basically, the main steps in the processing include two groups of processes which are applied before and after applying static correction computation. The first group include resampling, geometry update, minimum phase conversion, geometrical spreading and exponential gain, while the second group include mute , normal move out, deconvolution F-K filter, Random noise attenuation, F-X Coherent Noise Suppression, sorting, T-V filter and migration.

4. The parameters that are used in computation methodology of static corrections:

1. Reference datum or datum plane.
2. The elevation for all source and receiver stations and coordinates for each station.
3. Replacement velocity.

5. Computation Methodology of static corrections:

This search is to choose one seismic line from program survey and this line is (2wl2) dip line**.** As follows a detail of processing operations conducted on the line. We notice that the quality of data is bad due to type of area which is present in desert and contains sand dunes and sometime its layers are not appeared. So, these properties cause loss of energy, for this reason (the field recorded) seems to be weak and the reflectors cannot be seen**.** The near traces for these field shot contain high spike because they are close to the source of energy and the rest of shots are very weak due to the disappearance of energy. So, a geo spread compensation and gain were applied on the field shots to be seen clearly and treat disappearance that found in the energy for the purpose of doing some processing on it (noise removal) to be able to see the (static correction effect) clearly**.**

5-1 Elevation static correction:

Many processes are used in calculation of elevation static correction as illustrated in Figure-3. Parts of this process are used in all types of static correction to enhance the quality of the sections. Computation of elevation static correction includes many steps which are:

1. In the omega program, we utilized the field measured elevation values for shots and receiver, meanwhile the datum plan that was used to calculate elevation static is the sea level.

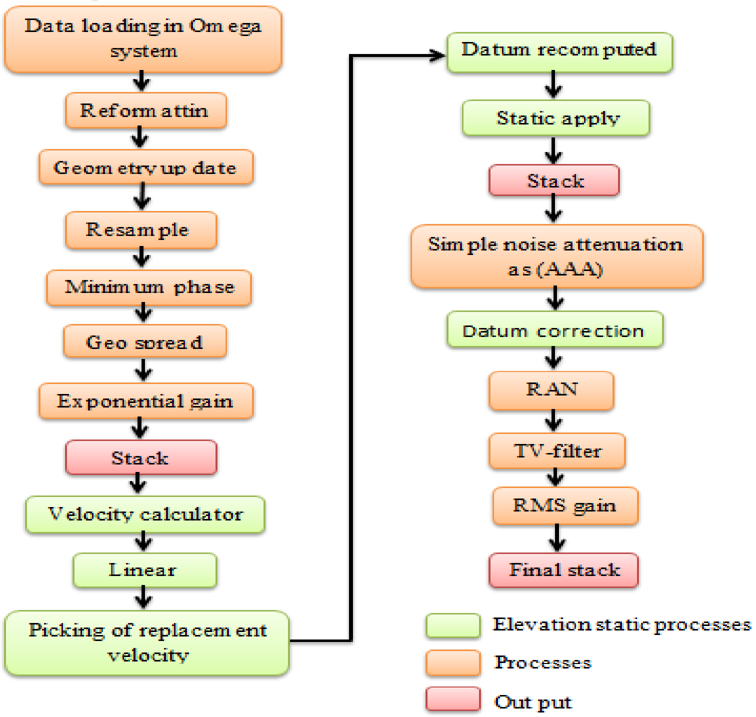

Figure 3- A Flow chart shows steps that are used for the calculation of elevation static correction to get the final stack.

2. The velocity measured from field shots, Figure-4 represents the replacement velocity which obtained by using velocity calculator program. This program produce direct reading for the average velocity value where this value represents replacement velocity. During the working on the velocity calculator program, one window appeared in the screen which has two possible options, the first one is RMS velocity and the second one is the linear velocity. The second one is used in picking of the replacement velocity value.

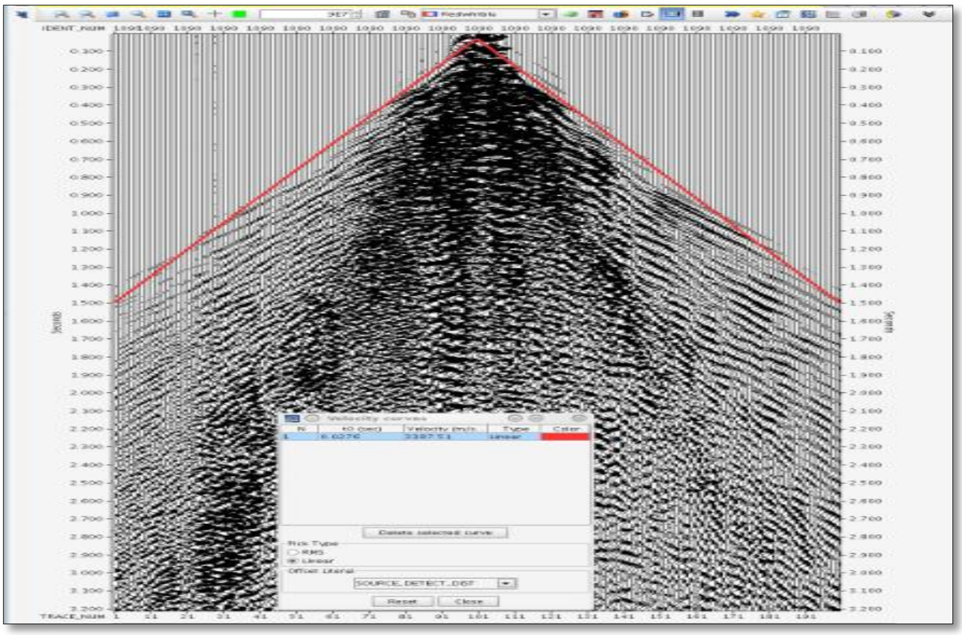

Figure 4- Picking of replacement velocity.

3. After picking the velocity value, it was applied in the elevation static correction in addition to the using of elevation values of the source and reception points, and datum plan. Source static correction (SSC) and receiver static correction (RSC) are computed and then applied on the raw section, see Figure-5.
Later, as it shown in Figure-5 raw stacked section is displaced where we have used geospread, gain and applied elevation static on it, but without using noise attenuation, so, we cannot use the stacked section in comparison between results of static correction because the quality of reflectors is bad due to the presence of high rate noise to signal.

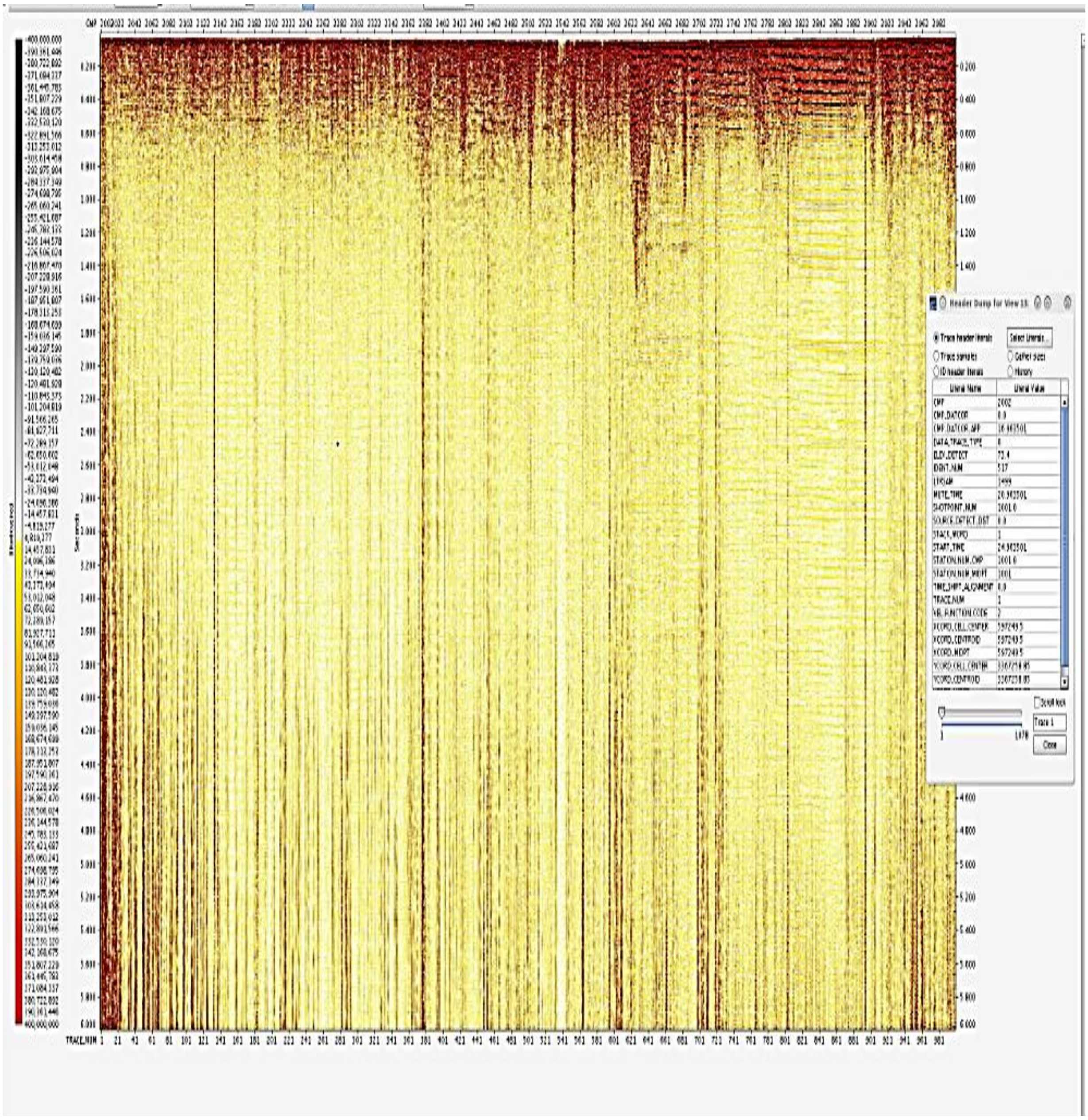

Figure 5- Applying geo spread and gain on raw stacked section of the line (2WL2) without using noise attenuation and with using elevation static.

Since the noise prevent us to see the reflectors on stacks clearly, so simple noise attenuation was applied on the shot records to make the stacking more reasonable.

A. Noise attenuation:

The field shots records are of bad quality which means that no reflections are shown. These records contain different types of noise which are:

1- Abnormal amplitude noise: It's one of the random noise types, which appear on the field record as abnormal amplitudes (spike, high, low amplitude or unique frequency) see Figure-6.

2- Head waves: Its one of the coherent noise types which appears on the field record as covering the good data. The head wave is a surface waves generated by the source itself in the low velocity layers **[4]**.

3- Airwaves: are types of electromagnetic radiation with wavelengths in the electromagnetic spectrum longer than infrared light. Air waves have frequencies from 300 GHz to as low as 3 kHz, and corresponding wavelengths ranging from 1 millimeter (0.039 in) to 100 kilometers (62 mi), they travel in the speed of light. Naturally occurring air waves are made by lightning, or by objects, see Figure-6 [4].

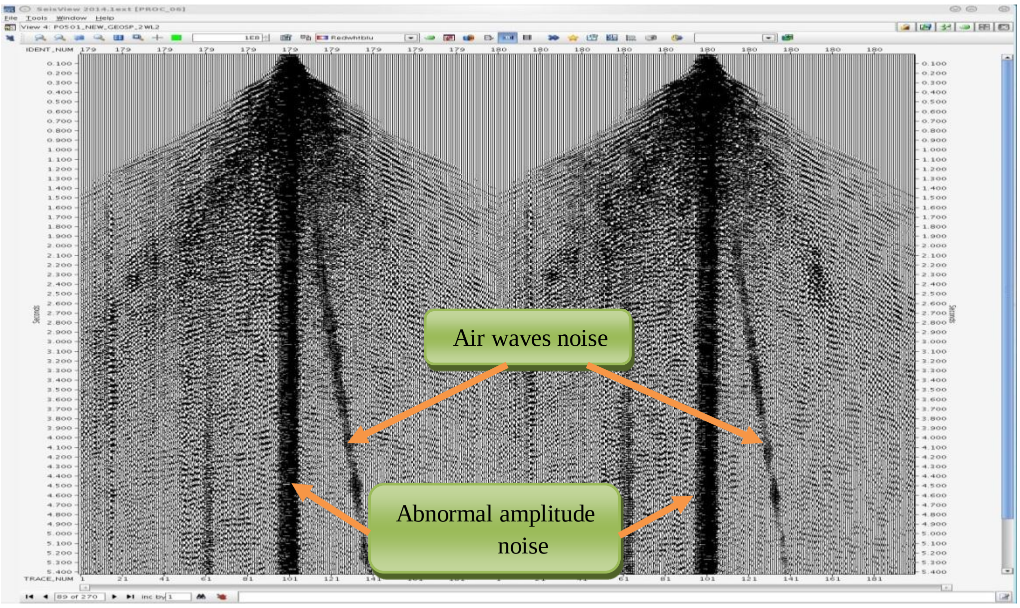

Figure 6- Types of noise that appeared in (2WL2) records which are removed from the seismic signal

B. Spectral analysis:

Basically, the waveform is a sum of weighted, time-shifted cosine waves of different frequencies. The amplitude spectrum of the waveform is equal to the weights of the cosine waves, and the phase spectrum is equal to the ratios of time-shift to period at each frequency. The output from spectral analysis can be used for deconvolution operator design. The output data may be represented in the time domain as autocorrelations or in the frequency domain as magnitude and phase spectra. Spectral analysis is a process in OMEGA system to display the amplitude spectrum of a given seismic shot data. This diagram helps us to analyze data to predict the signal and noise distribution in frequency domain Figure-7. Also, spectral analysis is used in seismic data processing for parameter selection, quality control, data interpretation, wavelet estimation, and as part of deconvolution processing [4].

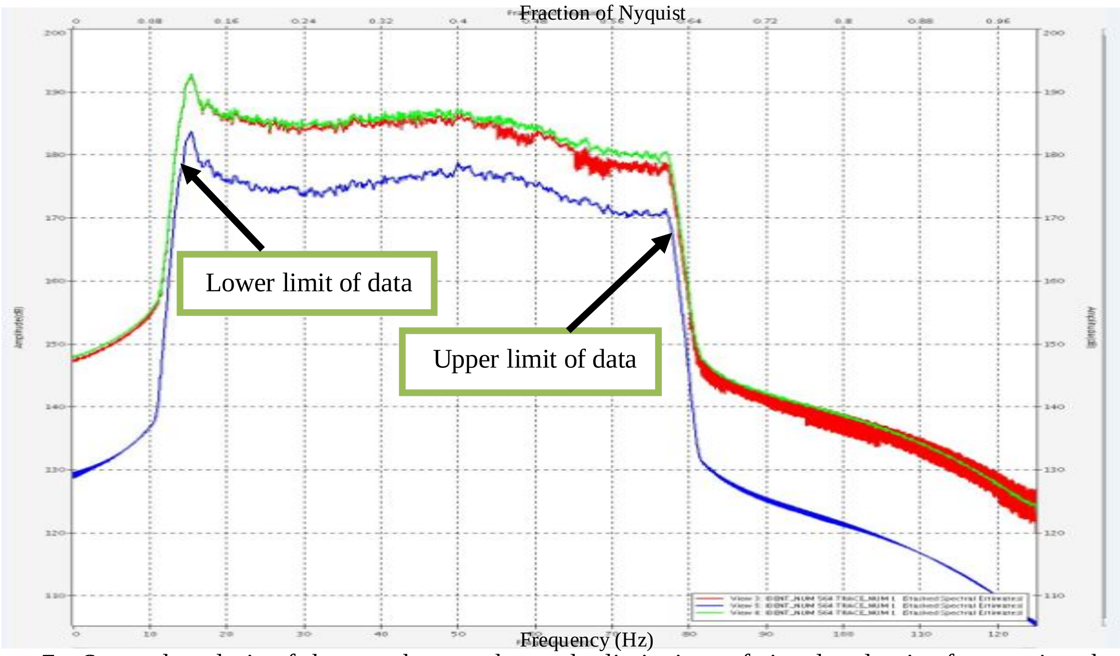

Figure 7- Spectral analysis of the test shots to know the limitations of signal and noise frequencies, the line blue is data field, the line green after gain apply and the line red represented data after noise attenuation process apply.

C. Band- passes filter panels:

This filter is used to remove the noise for a frequency band window of seismic data. Normally it is applied to the data which have amplitude spectrum frequency content more than 80Hz and less than

10Hz. So for given shot records as shown in figure (8) one can design eight band-pass filters for the frequency ranges (F_1=10-20),(F_2=20-30),(F_3=30-40),(F_4=40-50),(F_5=50-60),(F_6=60-70),(F_7=70-80),(F_8=80-90) Hz,. The examination of the resulted displays is of great interest in defining the noise frequency to be removed from the data. Where one can choose the suitable window for given times. In other words selecting the appropriate frequency band which correspond reflection time. This is called time –variant filter (TVF).

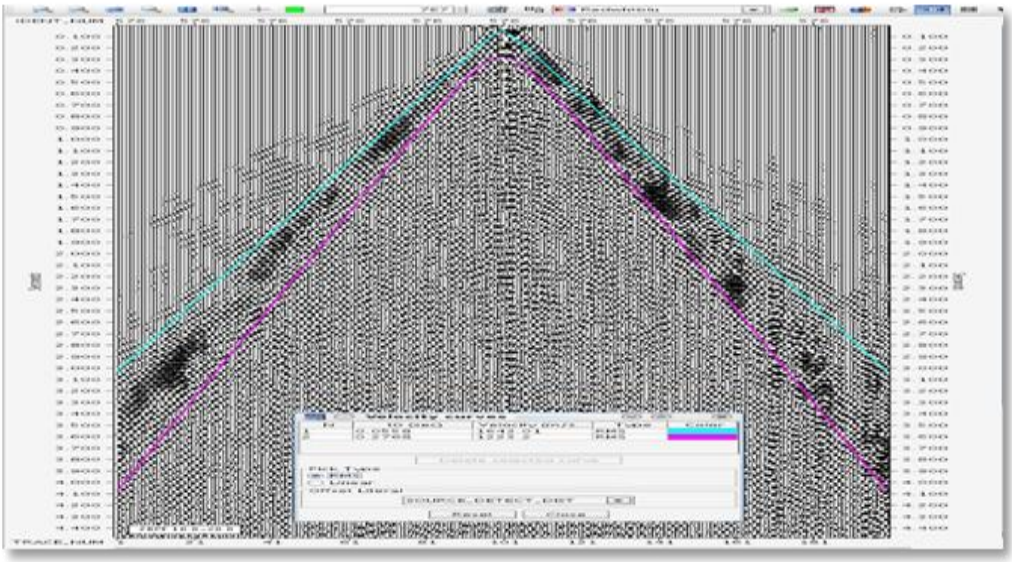

Figure 8- One pannal (10- 20 Hz) of band pass filter for (2WL4) records to show head waves frequency and velocity.

After applying (TVf) and making a detailed spectral analysis on the field data, the noise frequencies become known. Consequently noise attenuation processes were applied to remove the noise and enhancing the signal which leads to clear vision of the reflectors. Figure-9 shows a field record before and after the using of anomalous amplitude noise attenuation (AAA). The above mentioned processes are listed in the flow chart of Figure-3.

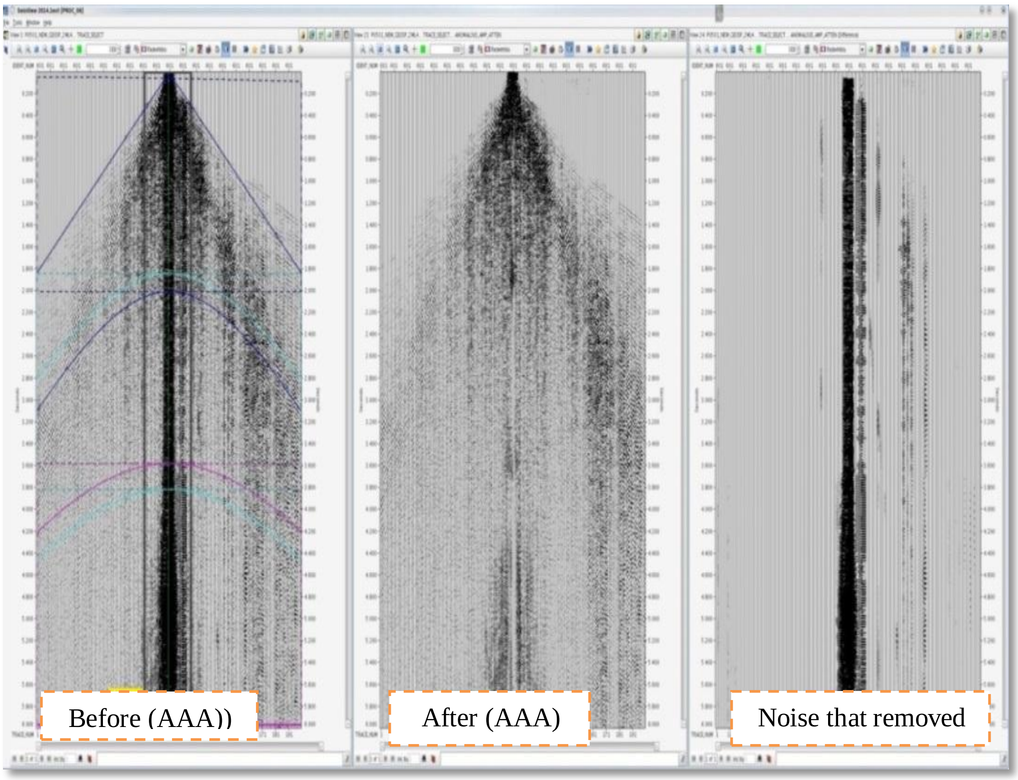

Figure 9-Using of (AAA) process on a given field record (2WL2).

Examination of the stacked section of the study line displayed in Figure-10 left, reveals that the qualities of the (Sadi, Zubair and Gotnia) reflectors are bad due to the discontinuity. This is attributed to the non-application of the static correction, the reflectors are picked from the final seismic section rely on the synthetic seismogram of Khaddar Al-maa(Kl) well as shown Figure-11. In contrary, as illustrated in Figures-10 right, the quality of the studied reflectors are enhanced where they becomes more easy to follow them along the section.

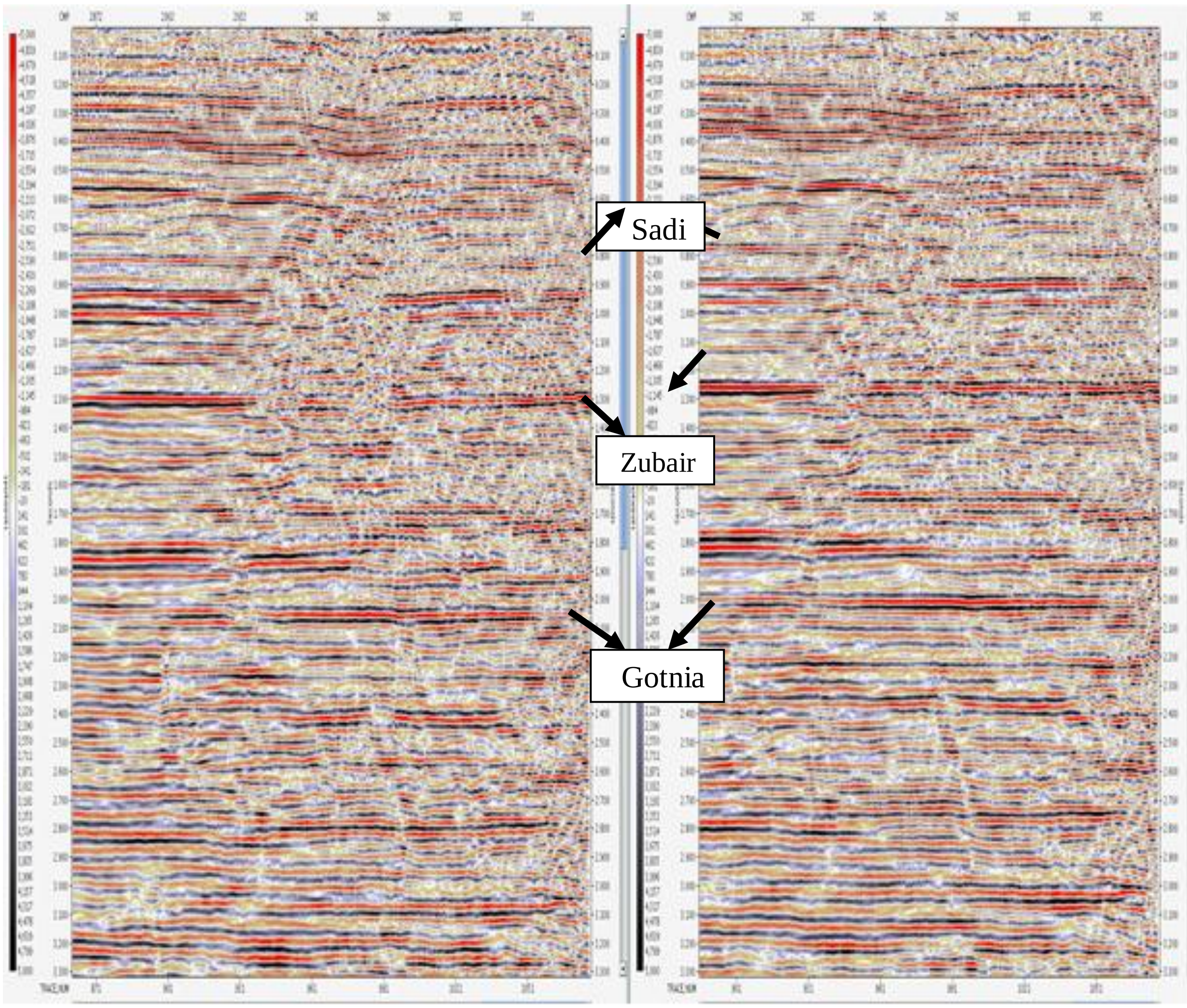

Figure 10- Final Stacked sections for (2WL2): (left) before applying elevation static correction; (right) after applying elevation static correction.

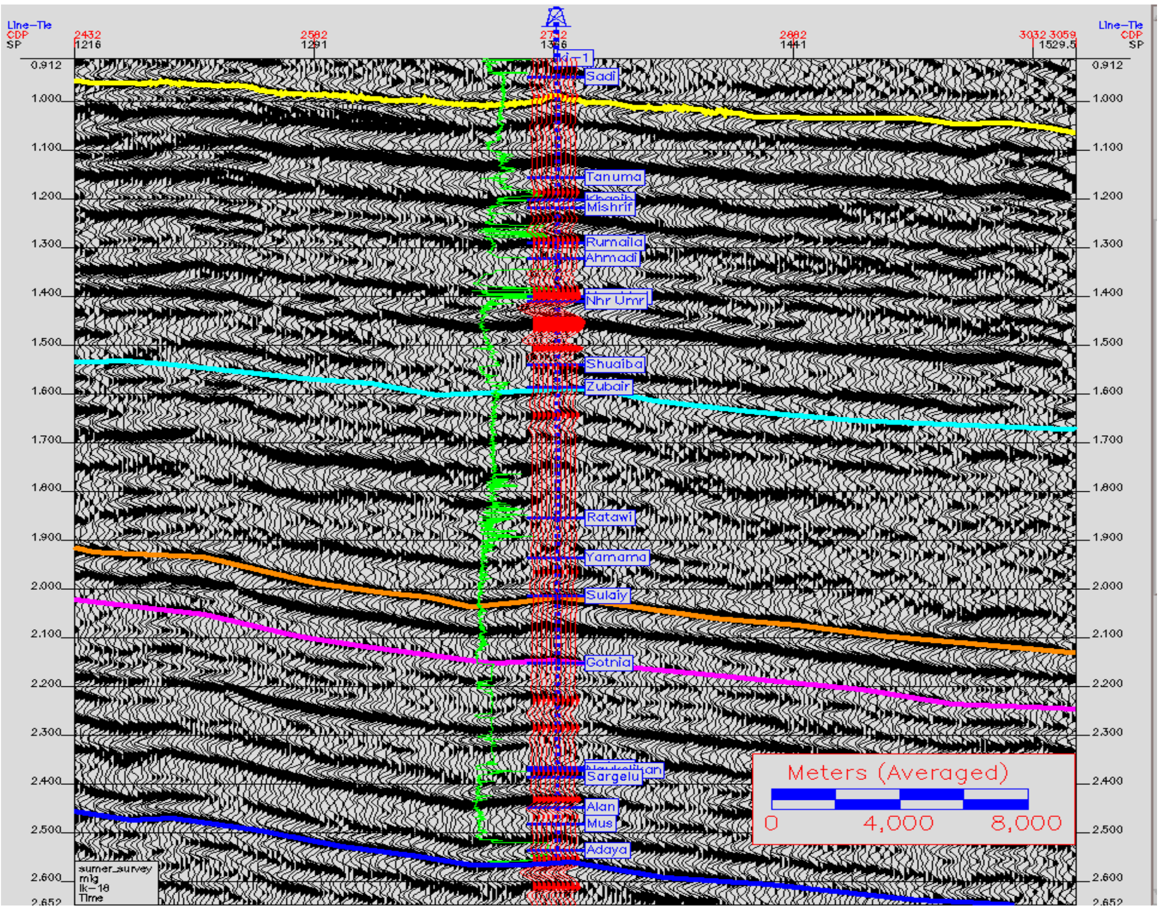

Figure 11- Synthetic seismogram of Khaddar Al-maa well.

5-2 Residual static correction

The computation and application of residual statics is an essential part of all land and some shallow-marine processing. After calculating different types of static correction, the residual static correction is calculated. In the present work, we have computed the residual static for all types of static correction (elevation, refraction, and field). Need to preconditioning the data before the computation of residual static, so many steps for data preparing are used in residual static calculated. The main steps are:-

1. Using the same steps that were used in calculation of the elevation, see Figure-3.
2. The results (stacks) of the elevation are used as input.
3. The data must be gathered in common midpoint (CMP) gather sort.
4. Normal move out (NMO) corrections must be applied.
5. Muting should be applied since the data were to be stacked.
6. Using of the filtering and gain.

After preparing the data, two programs the expert and reflection miser are used to calculate the residual static correction.

After application of the residual static correction through the using of (elevation) static correction, we have obtained the final stacked section as shown in Figure-11. The quality of the reflectors is good in case of using elevation correction.

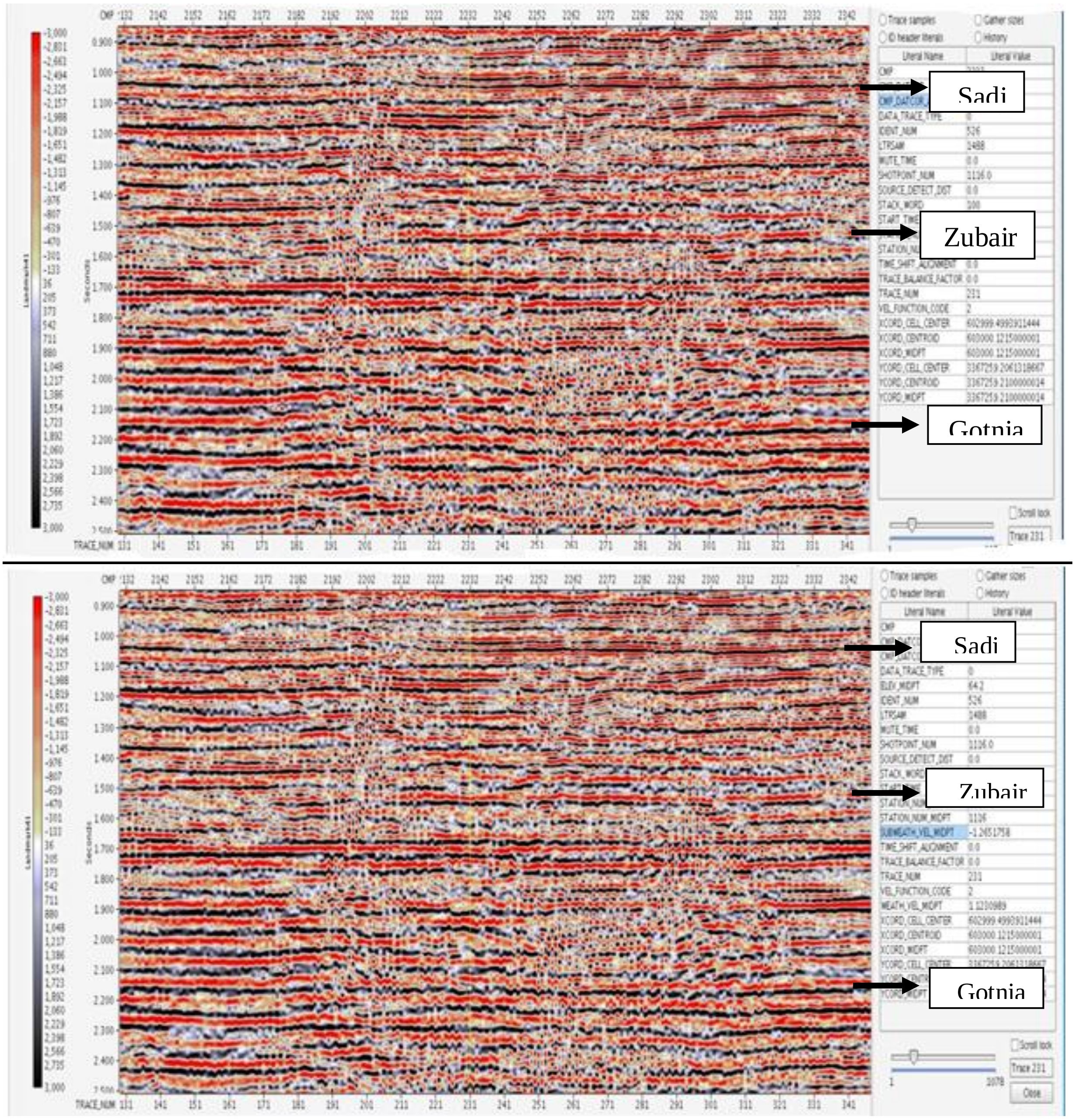

Figure 11- Final stacked sections: (top) before applying a residual static correction; (bottom) after applying a residual using elevation static for the line (2WL2).

Conclusion

Based on the results and discussion given in this study the following major conclusions and recommendations can be made:

1. A processing work on seismic line (2WL2) selected from west luhais area is done .In this work two types of static correction are applied for the aim of enhancing the quality of the stacked section. The processing includes two process stages one before and another after the applying of static correction. The using of these corrections on the data of the seismic lines shows that elevation static correction gives good results**.**
2. Two types of static correction were calculated, they are:
   - **a.** Elevation static is calculated depending on the elevation of receiver and source points, the replacement velocity value and the datum plane, give good results**.**
   - **b.** A residual static correction is computed with the above mentioned correction. The result is similar to that of elevation static. A simple partial enhancement in shallow part of final stacked section was noticed.

References

1. Sroor, M. **2010.** Geology and Geophysics in Oil Exploration. Report.
2. Oil Exploration Company (O.E.C) **.1983.** Interpretations of seismic survey in west luhais area, (Internal Report).
3. Oil Exploration Company O.E.C. **1989.** Study interpretations of seismic survey in west luhais static correction, third seismic crew, (Internal Report).
4. Oil Exploration Company (O.E.C). **2014a.** *Report of 2D seismic survey project for the Sumer oil field.*
5. Jassim, S.Z., and Goff, G.C. **2006**. *Geology of Iraq*, published by Dolin, Prague and Moravian Museum, Brno 2006.First Edition, p:63.
6. Drijkoningen, G.G., and Verschuur, D.J. **2003.** *Seismic Data Processing*, Centre for Technical Geoscience (CTG), Delft University of Technology.
7. Hao, J., Yang, R. J., Wu, J. **2011.** Processing of Static Correction Problems of Seismic Data in the Complex Surface. *Complex Hydrocarbon Reservoirs*, 4(3), pp:34–37**.**
8. Luo,Y.W., Yang, J., Duan, W. X. **2010.** Comparing Between Several Static Corrections Methods. *Petroleum Instruments*, 24(5), pp: 41–43.
9. Han, X. L., Yang, C. C., Ma, S. H.**2008.** Static of Tomographic Inversion by First Breaks in Complex areas**.** *Progress in Geophysics*, 23(2), pp: 475-483.
10. Wang, S. D. **2005.** Static Corrections of Complex Topography Based Wave Equation Datuming. *OGP*. 40(1), pp: 31–34.
11. Yang, W.J., Duan, Y. Q., Jiang, W. C. **2005.** Tomographic Statics. *Geophysical and Geochemical Exploration,* 29(1), pp: 41–43.
12. Henley, D.C. **2012.** Interferometric Application to Static Corrections. *Geophysics,* 77(1), pp: Q1–Q13.
13. Li, L., Chen, X. J., Jing, X. L.**2011.** Multiscale Inversion Algorithm for Seismic Residual Static Correction and Its Application. *Petroleum Geology*, 32(4), pp: 402–405**.**
14. Sheriff, R. E. **1991.** *Encyclopedic Dictionary of Exploration Geophysics*: Soc. Expl. Geophys.
15. Cox, M. **1999.** *Static Corrections for Seismic Reflection Surveys: Society of Exploration Geophysicists* Publ. Tulsa, Oklahoma.