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Application of the Surface- consistent DE convolution on a seismic data of Al-Najaf and Al-Muthanna Governorates in the south of Iraq

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Abstract

This study deals with the application of surface-consistent deconvolution to the two-dimensional seismic data applied to the Block 11 area within the administrative boundaries of Najaf and Muthanna Governorates with an area of $4822km^2$, the processed seismic data of line (7Gn 21) is 54 km long. The study was conducted within the Processing Department of the Oil Exploration Company. The gap surface-consistent deconvolution was applied using best results of the parameters applied were: The length of the operator 240, the gap operator 24, the white noise 0.01%, the seismic sections of this type showed improvement with the decay of the existing complications and thus give a good continuity of the reflectors at the expense of resolution.Then, spiking surface- consistent deconvolution was applied using the best implementation parameters chosen during the test: operator length 240, gap operator 4, and added white noise 0.01%. This type gave a better estimate of reflectivity in seismic sections with good resolution and loss of continuity compared to gap surface- consistent deconvolution. The application of surface-consistent deconvolution to seismic data showed a significant improvement in data quality by reducing random noise, eliminating variability in emissions due to near-surface irregularities, and improving the estimation of statistics.

Keywords: Gap and spiking surface- consistent deconvolution, seismic data, Najaf and Muthanna Governorates, Iraq

تطبيق التفلل متسق السطح على البيانات الزلزالية في محافظتي النجف والمثنى جنوب العراق

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الخلاصة

تتناول هذه الدراسة تطبيق التفلل متسق السطح على البيانات الزلزالية ثنائية الابعاد والتي طبقت على منطقة بلوك11 الواقعة ضمن الحدود الادارية لمحافظتي النجف والمثنى والتي تبلغ مساحتها 4822 كيلومتر مربع ، حيث تم معالجة البيانات الزلزالية الحقلية لخط زلزالي هو (7Gn 21) بطول 54 كم. اجريت الدراسة ضمن قسم المعالجة في شركة الاستكشافات النفطية. تم تطبيق التفلل متسق السطح المفتوح باستخدام معلمات التنفيذ وتم اختيار افضل المعلمات من حيث النتيجة وهي: طول المشغل 240، مشغل الفجوة 24، والضوضاء البيضاء 0.01% اظهرت المقاطع الزلزالية لهذا النوع تحسنا مع اضمحلال المضاعفات الموجودة وبذلك اعطى استمرارية جيدة للعواكس على حساب الدقة. بعد ذلك تم تطبيق التفلل متسق السطح النبضي باستخدام افضل معلمات تنفيذ تم اختيارها اثناء الاختبار وهي: طول المشغل 240، مشغل الفجوة 4، والضوضاء البيضاء المضافة 0.01% اعطى هذا النوع تقدير افضل للانعكاسية في المقاطع الزلزالية مع دقة

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جيدة وفقدان الاستمرارية الواضحة مقارنة بالتفلل متسق السطح المفتوح. ويظهر تطبيق التفلل متسق السطح على البيانات الزلزالية تحسنا كبيرا في جودة البيانات من خلال تقليل الضوضاء العشوائية، وازالة المتغيرات في الاتساعات بسبب الشواذ القريبة من السطح، وتحسين التقديرات الاحصائيات.

Introduction:

The seismic method is one of the most important geophysical techniques and most commonly used in oil exploration due to several different factors, the most important of which is the high accuracy and great penetration of what is under the surface of the earth [1]. Rocks nature and its bearing capacities are the main factors that must be taken into consideration during geophysical surveys [2, 3]. The definition of deconvolution is a filtering process that removes a wavelet from the recorded seismic trace [4], and is this done by reversing the process of convolution [5].In seismic oil exploration, particularly in the study of reservoirs, deconvolution is an important step of seismic processing, applied to improve temporal resolution of traces, allowing better top and bottom identification of thinner layers and thus better definition of subsurface geology [6]. Deconvolution is also used to attenuate multiple reflections that occur when the seismic energy is reflected more than once at each interface. In this case, the multiple reflections are considered as noise to be eliminated [7]. Surface Consistent deconvolution uses the redundancy of multifold data to statistically determine and attenuate effects on signal waveform that occur in the vicinity of each source and receiver position [8]. The study area (block11) is located in the southern part of Iraq within the administrative boundaries of Al Muthanna and Najaf governorates in Western Desert (Figure-1), the remains of the Palaeocene age in the southwestern part of study area are represented by the Formation of Umm Er-Radumah (limestone). The rest of the region is covered by the lower and middle Eocene rocks represented by the Formation of Dammam (limestone) and a small patch of the lower Miocene is represented by the Formation of Al- Ghar (sand, clay, sandstone). The area of the survey was lacking in the drilling wells. In order to identify the stratigraphic sequence, its rocky nature and the depth of the formation, it was based on the well Ghalaisan -1, which was drilled in 1960 and located in the middle of the survey area. However, the area's deep-seated geological studies were based on the subsurface geological information of the Diwan-1 well as a deep well in the region [9]. The study area lies within Salman zone of stable shelf according to the tectonic map of Iraq modified from GEOSURV [10]. The aim of this research is to apply surface- consistent deconvolution on selected seismic data.

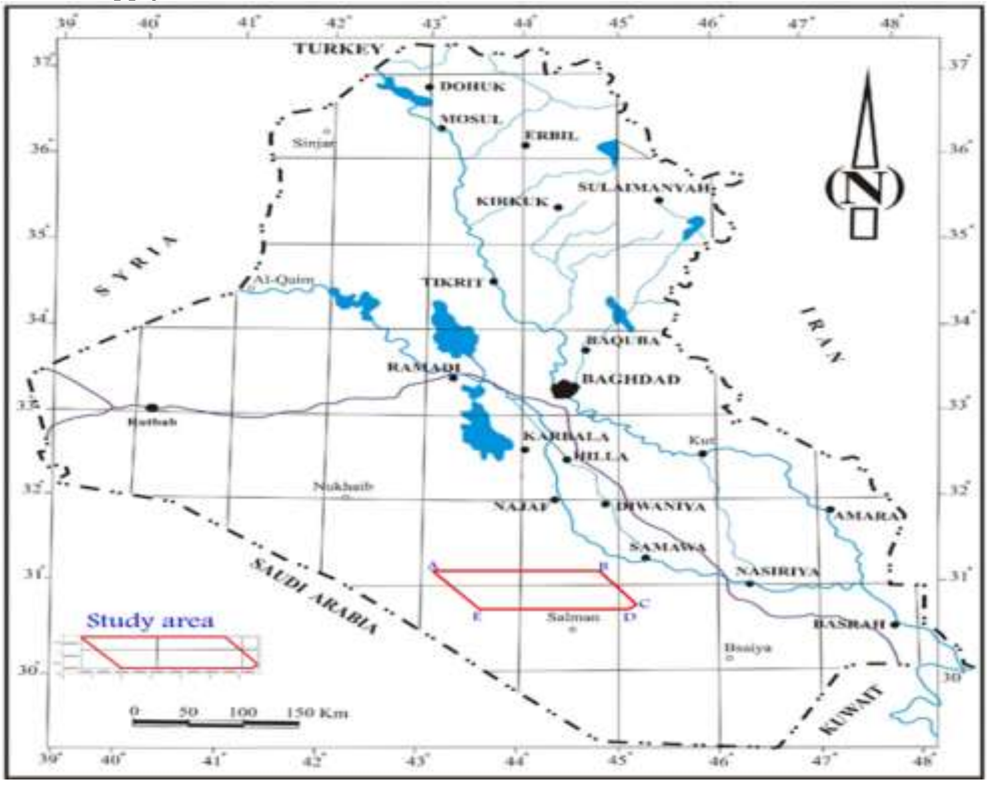

Figure 1- Location map of study area

Theoretical Background

Processing is a series of treatments to sort and rearrange raw data (field) by adding more data (corrections), rejecting some data (filtering), and finally displaying the result as a usable seismic section. The objectives of the processing are improved signal to noise ratio, increasing resolution, provide velocity information and correct the effect of near-surface time delays (static correction) ..etc. These processes or objectives are achieved using computers, and include many mathematical operations based on physical fundamentals .There are three major processes in the processing of seismic data (deconvolution, stacking, migration) [11]. The deconvolution process is usually performed on seismic data before it is stacked, and this is on unstacked traces [12]. In most cases, the objective of deconvolution is to increase the time resolution of seismic data [13].

Surface-Consistent Deconvolution:

Surface- consistent deconvolution is widely employed in the seismic exploration industry due to its stability in the presence of noise. It is often overlooked that surface- consistent deconvolution may still have trouble handling certain types of noise. Deconvolution can be formulated as a surface-consistent spectral decomposition [14]. In such a formulation, the seismic trace is decomposed into the convolutional effects of source, receiver, offset, and the earth’s impulse response, thus explicitly accounting for variations in wavelet shape affected by near-source and near-receiver conditions and source receiver separation. Decomposition is followed by inverse filtering to recover the earth’s impulse response. The assumption of surface-consistency implies that the basic wavelet shape depends only on the source and receiver locations, and not on the details of the ray path from source to reflector to receiver [15].

Processing of data:

Processing works are semi-fixed for each processing center. Although the processing center varies greatly from one center to another, the processes are similar in terms of scientific and technical basis, which may produce different degrees of quality of the output displays [16]. According to the Iraqi Oil Exploration Company's plan, 2D survey was conducted for block 11 of Al Muthanna and Najaf governorates which represents 4822 km^2 study area. The project program was implemented by the Iraqi seismic crew of the Oil Exploration Company with a coverage of 2400% using vibrator as an energy source and normal geophones. The propagation type was a symmetrical spread, while the datum plane was 250 m below sea level. The current study adopted a method followed by the Iraqi Oil Exploration Company, which gives qualitative results which are not different from the results of the methods approved by the international oil companies. It was noticed that the quality of data is generally bad due to the study area which may cause problems in the reflections, so a geospread compensation was applied on the field shots to make them clear and to treat disappearance that found in the energy to be able to see the effect of deconvolution. For this purpose, the line (7Gn 21) in the study area was processed. The seismic data processing of the line is obtained at the processing center of the Oil Exploration Company, according to the traditional processing sequence using the omega system. Figure-2 represents flow chart of the processing sequence of deconvolution in current study.

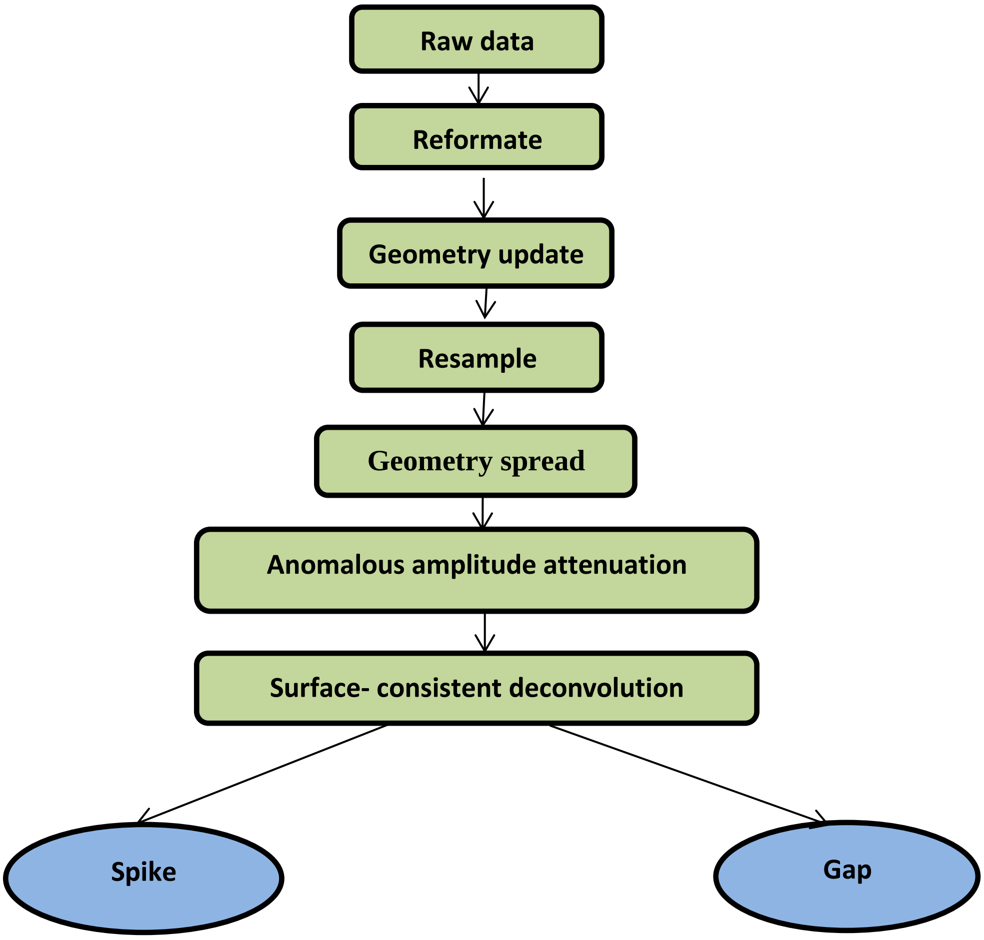

Figure 2- Flow chart of the processing sequence of surface- consistent deconvolution

Results and conclusions:

Surface-consistent deconvolution is commonly applied to terrestrial seismic data and AVO as well as inversion processing. This technique involves traces of the same surface source and location of the receiver (CMP, offset in addition) having the same consistent operator. The performance of surface-consistent deconvolution techniques is the best applied to the first reflection data only, due to the unevenness of the ground roll and multiples horizontally in the media with lateral variations. The surface consistent deconvolution is ideally suited for pre-stack processing, and the conditions close to the surface and their variation greatly affect data quality.

Improper correction or non-correction of near-surface anomalies during pre-processing of seismic data will reduce the accuracy of the surface under the surface of the Earth and negatively identify descriptions below the surface of the Earth based on reliable amplitude and phase information. Surface-consistent deconvolution can help to alleviate prevailing prejudices, as the near-surface effects on the wavelet are explained by the heterogeneity of the vicinity of sources and receivers.

Surface-consistent gapped deconvolution

This type is applied to the seismic data of the selected line (7Gn 21) using the operator length, operator gap and white noise. The function of these parameters is surface-consistent deconvolution itself in the predictive deconvolution. Several parameters were tested on the selected line: Operator length (140, 120, 160, 240), operator gap (16, 28, 24, 36). The parameters that gave the best result were operator length 240, operator gap 24 and white noise 0.01%.

Figure- 3 represents the shots and amplitude spectrum of the seismic line before and after the deconvolution. In the shot of the line (7Gn 21), an improvement is seen in hyberbola (800-1000) ms and also from (2600-3000) ms with decay of noise on the sides of the shot. Its noted that the improvement in the reflectors was happened with the decay of the existing complications. In the amplitude spectrum before the deconvolution, the frequency range of the real data is approximately 8 - 50 Hz. The deconvolution gap in this format improved this range for amplitude and frequency as shown in the blue figure, where it became smoother.

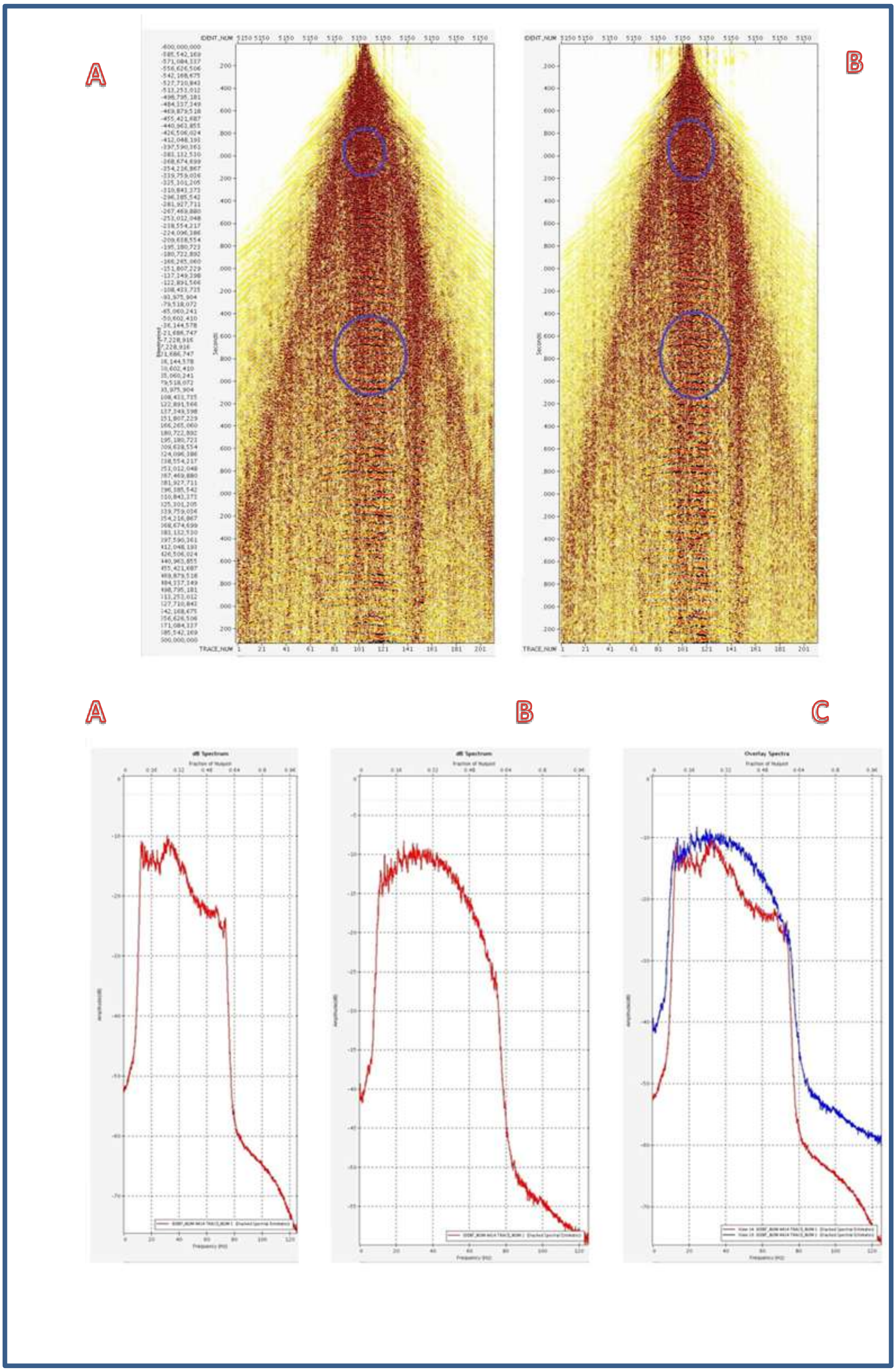

Figure 3- shows shots and amplitude spectrum for line (7Gn 21): (A) shot and spectral analysis before applying surface-consistent gapped deconvolution, (B) shot and spectral analysis after applying surface-consistent gapped deconvolution, (C) overlay spectral analysis, the red line before deconvolution and the blue line after applying deconvolution.

Figure- 4 shows the autocorrelation before and after the deconvolution. This type shows that it is a zero-lag in the middle, increasing the accuracy of the bandwidth and eliminating the side-lobes full fold but returned to the peripheral regions.

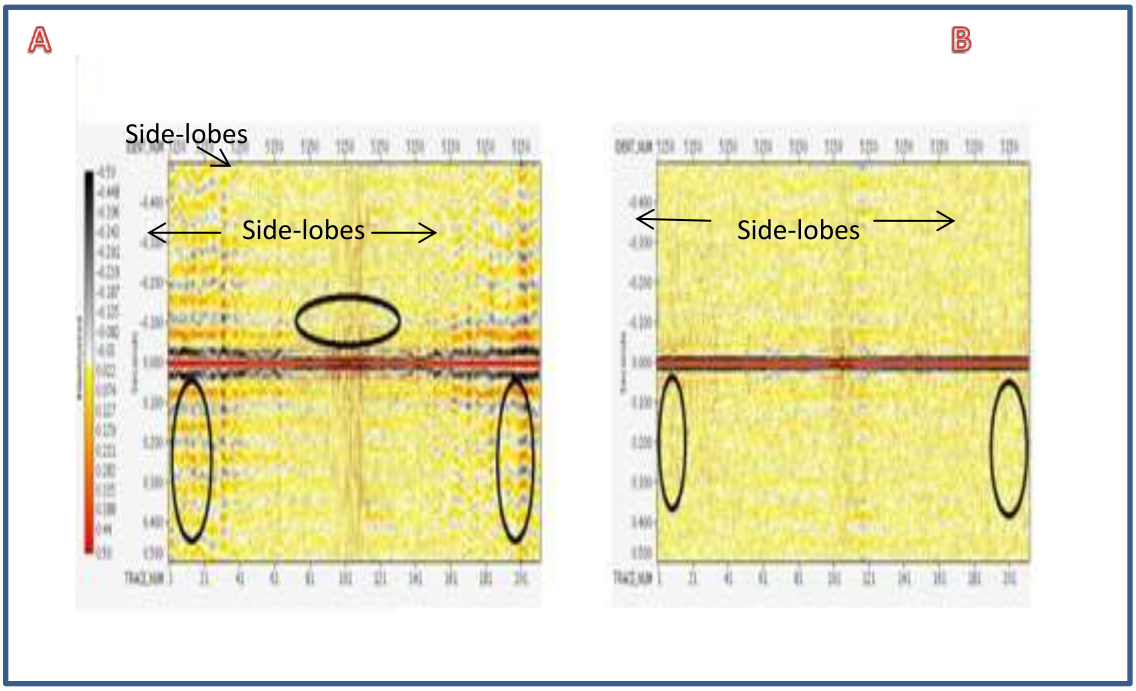

Figure 4- illustrates the autocorrelation for line (7Gn 21): (A) Before applying surface-consistent gapped deconvolution, (B) After applying surface-consistent gapped deconvolution

The final stack of the line was done by applying RMS amplitude gain (250 ms) and random noise attenuation, as well as a TV-filter on both lines. The following filters were applied:

10/14	40/50 Hz	0- 1600 Time (ms)
10/14	35/45 Hz	2200- 6000 Time (ms)

In the line it gave a good continuity of the reflectors and maintained the thickness of the reflectors because it did not change the shape of the wave, also caused to decay of the existing complications, but gave a little resolution compared to the spike of the same type with less possibility to increase noise compared to spike as in the Figure- 5.

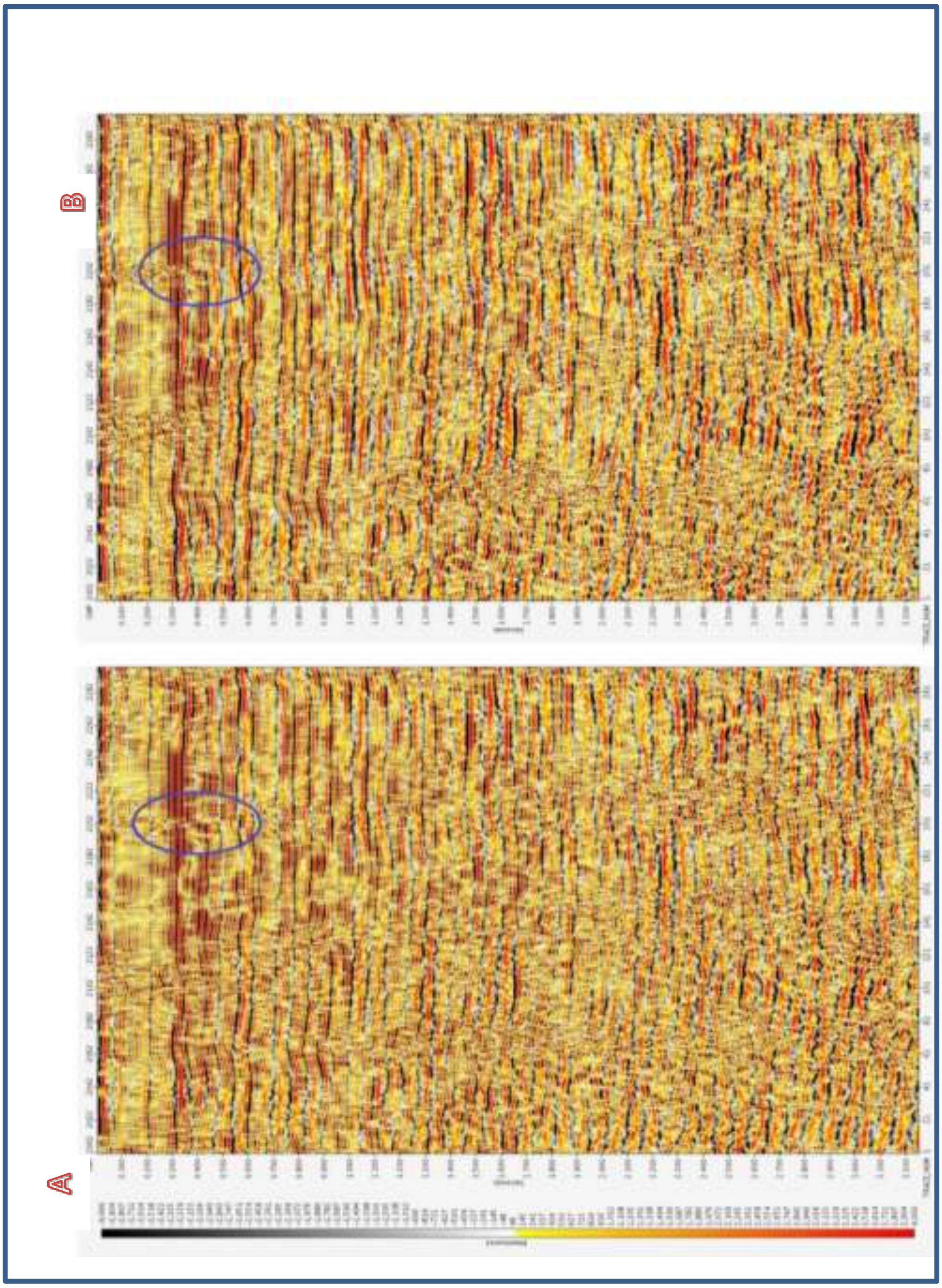

Figure 5- Final stacked section for line (7Gn 21): (A) Before applying surface-consistent gapped deconvolution, (B) After applying surface-consistent gapped deconvolution.

Surface-consistent spiking deconvolution:

This type is also applied to the data of the line (7Gn 21) using the operator gap, the white noise, since the function of these parameters is also not different from that of the other types applied . Since operator gap takes the sample rate in the spike type, a number of values for operator length are tested, these are (120, 140, 220, 240). The value (240) is the best operator length type and operator gap 4 as well as white noise 0.01%.

Figure- 6 represents the shots and amplitude spectrum of the seismic line, where in the shot, obvious improvement in the shape of the shot is noted, but eating from the bandwidth which means that the reflectors may also have eaten and unappeared in the shot domain. The shot was improved after the deconvolution was applied and the existing ones were clarified. In the amplitude spectrum after applying the deconvolution, the amplitude is amplified in the frequency range of 50-80 Hz almost semi-constant, that is, to make the capacitance value constant in this range given inverse amplitude, because range data from (8-50 Hz) and above this frequency is noise with high frequency.

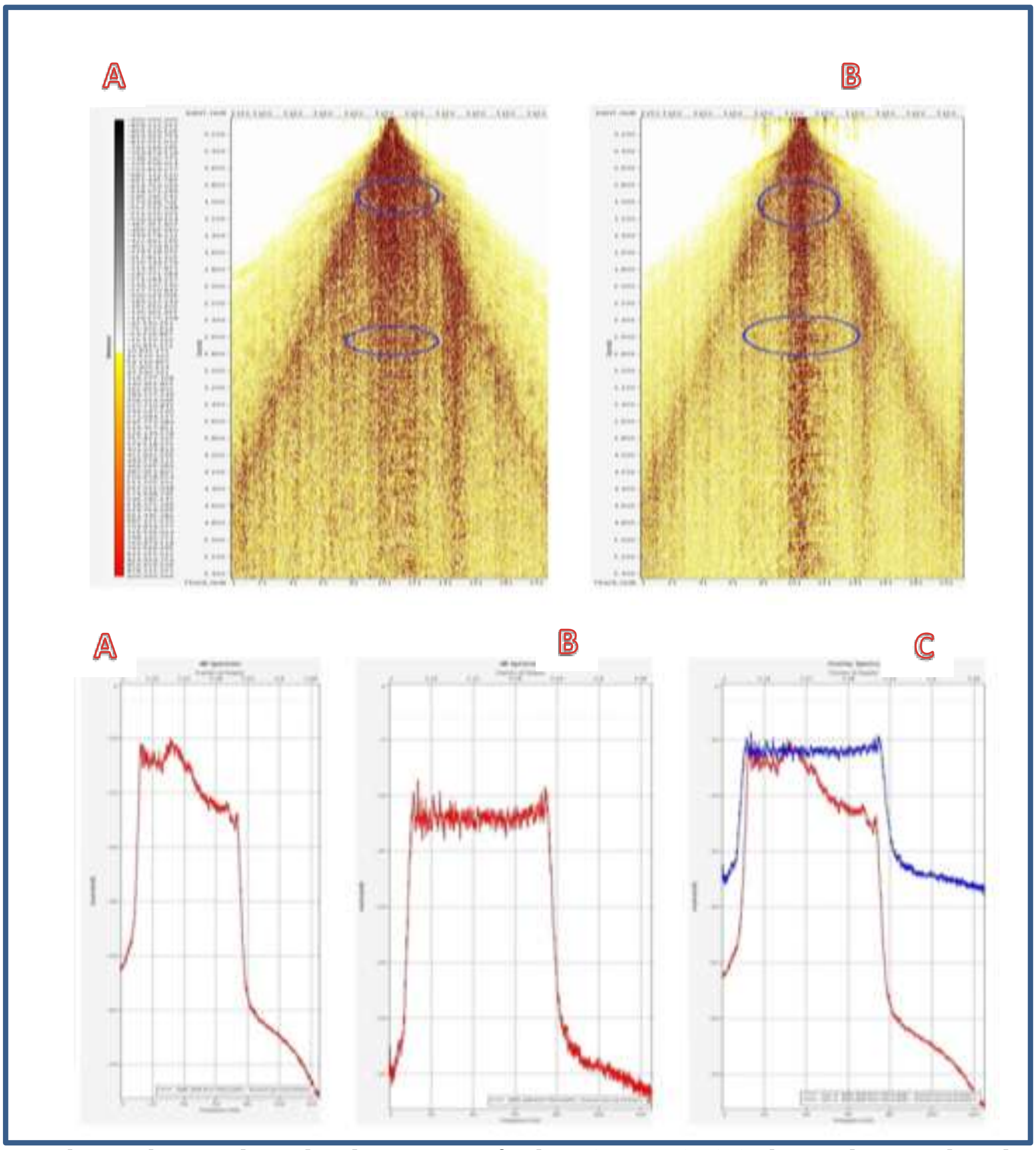

Figure 6- shows shots and amplitude spectrum for line (7Gn 21): (A) shot and spectral analysis before applying surface-consistent spiking deconvolution, (B) shot and spectral analysis after applying surface-consistent spiking deconvolution, (C) overlay spectral analysis, the red line before deconvolution and the blue line after applying deconvolution.

The Figure- 7 represents the autocorrelation before and after the deconvolution application. The waveform is more marginal with zero-lag and with side-lobes in the full fold area when applying the deconvolution, it removes the side-lobes on the sides but return them to the center.

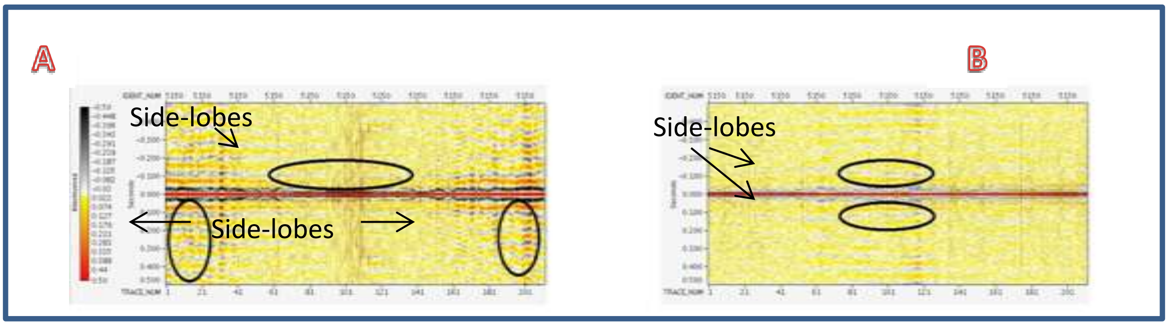

Figure 7- illustrate the autocorrelation for line (7Gn 21): (A) Before applying surface-consistent spiking deconvolution, (B) After applying surface-consistent spiking deconvolution

The final stack of the seismic line was obtained by applying RMS amplitude gain (250 ms) as well as random noise attenuation. The TV- filter was also applied with the following filters:

10/14 40/50 Hz 0- 1600 Time (ms)
10/14 35/45 Hz 2200- 6000 Time (ms)

It was also observed in this type that it gave a better estimate of reflectivity with a loss of continuity compared to the type of surface- consistent gapped deconvolution but it reflected good resolution, and the signal to noise ratio is low because of the high noise ratio at the expense of the signal as in the Figure- 8.

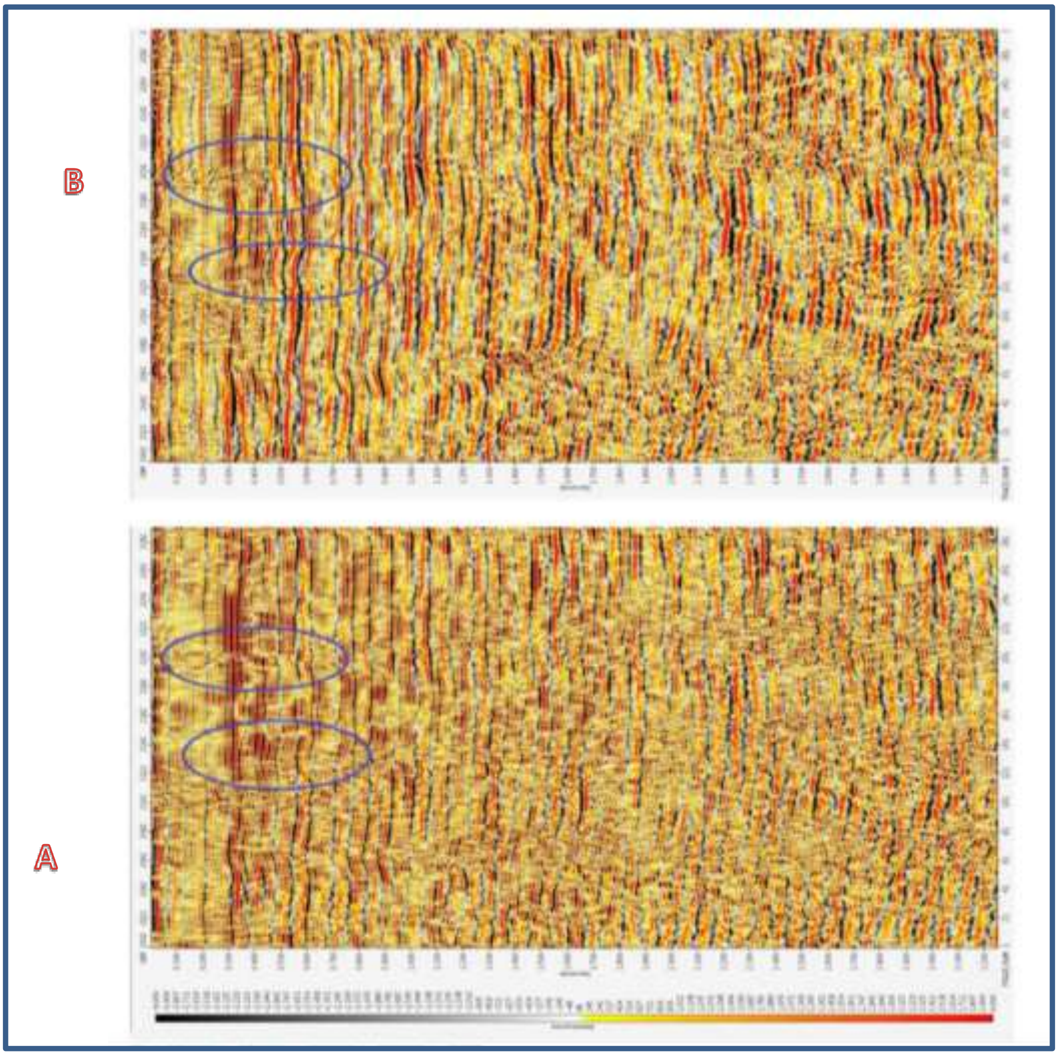

Figure 8- Final stacked section for line (7Gn 21): (A) Before applying surface-consistent spiking deconvolution, (B) After applying surface-consistent spiking deconvolution

Conclusions

1-Gapped surface consistent deconvolution gave an improvement in the shot with the decay of the existing multiples and also improved the range of amplitude and frequency for the amplitude spectrum and give good autocorrelation where it eliminated the existing noise and side-lobes, thus giving good continuity of the reflectors but give low resolution compared to spiking for the same type of deconvolution.

2-Spiking surface-consistent deconvolution gives an improvement in the shape of the shot, but eating from the bandwidth, in the amplitude spectrum increased the capacitance in a semi-constant line in the form of data.

References

1. Telford, W. M., Geldart, L. P. and Sheriff R. E. **1990.** *Applied Geophysics*, 2nd ed., Cambridge University Press.

2. Mousa, S. E. A. **2003.** Geophysical Site Investigation and Geotechnical Measurements At The Industrial Zone, North Sinai, Egypt, *Egs Journal*, **1**(1): 77 – 83.

3. Espinosa, G.L., Ceron, C.M. and Gamboa, M.M. **2006.** Preliminary Laboratory Research On Some Geophysical Properties Of The Shallow Sedimentary Calcareous Rocks Of The Yucatan Peninsula, Universidad Autonoma De Yucatan Merida, México, p43 – 51.

4. Claerbout, J. F. **1976.** Fundamentals of geophysical data processing, pp. 194-207.

5. Leinbach, J. **1995.** Wiener spiking deconvolution and minimum- phase wavelets: Atutorial. *The Leading Edge*, **14**(3): 189-192.

6. Robinson, E. A**. 1967.** Predictive deconvolution of time series with application to seismic exploration. *Geophysics*, **32**: 418-484.

7. Robinson, E. A. and Treitel, S. **1982.** *Geophysical signal analysis*. Prentice- Hall, inc., 466 pp.

8. Gadallah M. R. and Fisher, R. **2009.** *Exploration Geophysics*, Springer-Verlag Berlin Heidelberg, 262 p.

9. Oil Exploration Company. **2015.** Report of 2D seismic survey project for the block 11 . A /1/230, OES, Baghdad, Iraq.

10. Buday, T. and Jassim, S.Z. **1984.** Geological map of Iraq 1:1,000,000 scale Series,sheet No.2,Tectonic Map of Iraq.Publication of GEOSURV,Baghdad..

11. Yilmaz, O. **1987.** Seismic Data Processing, SEG, Investigations in geophysics V. 2, Tulsa, SEG, 526 p.

12. Coffeen, T., Butler, L., Low, L., Wartick, J. and Helen, M. **1978.** Seismic exploration fundamentals.122p.

13. Drijkoningen, G.G. and Verschuur, D.J. **2003.** Seismic Data Processing, Centre for Technical Geoscience (CTG), Delft University of Technology,58p.

14. Taner, M. T. and Coburn, K. **1981.** Surface-consistentdeconvolution: Presented at the 51st Ann. Internat. Mtg., Soc. Expl. Geophys.

15. Yilmaz O. **2008.** Seismic Data Analysis, *J. Society of Exploration Geophysics*, 2028 p.

16. Owaina, F. H. **1996.** Three Dimensional seismic of Kifl area- central Iraq. UnPub.PhD Thesis, University of Baghdad, 74 p.