DOI:10.24996/ijs.2018.59.1A.17

ISSN: 0067-2904

Inversion to density and velocity model by integrated with wells data at regional area (central and southwestern Iraq)

Ahmed S. AL-Banna, Salar S. Al- Karadaghi*
Department of Geology, College of Science, University of Baghdad, Baghdad, Iraq.

Abstract

A new derivative applied to the old gravity Bouguer map (served in 1940_s and 1950s), taking regional study area covered the mid and south of Iraq. The gravity anomaly reflects a density contrast variation; therefore it is possible to use gravity inversion to the density and velocity model through layers (615m, 1100m, 1910m, 2750m and 5290m), the depth layers according to the power spectrum analysis of gravity Bouguer. The inversion is according to the integration of gravity anomalies of the each depth layer with the same depth of wells data, considered to the estimations and analysis of density and velocity scatters of the oil wells distribution with depth at the regional area. Taking the relation curve of density and velocity by presenting the function of (8 logs), which obtained the main relation to Seismic velocity and density of the study area, which is confirm with (Nafe and Drake curve). The result of the gravity inversion is on the anomalies behavior in density and velocity domain, taking in seismic stack processing of seismic reflection records and time to depth conversion, as the geophysical integration data is addition to the well data distribution in the regional area of Iraq. Good results obtained on comparing the interpretation of the considered seismic section in the study area.

Keywords: Inversion, Regional, Power Spectrum, Density and Velocity Models.

التحول إلى موديل الكثافة والسرعة خلال التكامل مع بيانات الآبار لمنطقة إقليمية (وسط وجنوب غرب العراق)

أحمد شهاب البناء ، سالار سعدي حسن القره داغي*
قسم علوم الأرض، كلية العلوم، جامعة بغداد، بغداد ، العراق

الخلاصة

تم تطبيق إشتقاق من نوع جديد للخريطة الجذبية لشواذ بوجير المنفذة في الأربعينات والخمسينات من القرن الماضيضمن منطقة إقليمية تغطي وسط و جنوب العراق، حيث أن الشواذ الجذبية تعكس تغاير الكثافات للمستوياتالعمقية. تم إستخدام المعكوس الجذبي لإخراج موديل الكثافة والسرع ضمن المستويات: (5290م، 2750م، 1910م، 1100م و 615م). أعماق هذه المستويات تحددت من خلال تحليل الطاقة الطيفي للخريطة الجذبية، والمعكوس تحدد بالتكامل بين الشواذ الجذبية لكل مستوى عمقي مع معلومات الآبار، مأخوذ بنظر الإعتبار حسابات وتحاليل قيم الكثافة والسرع من توزيع الآبار بأعماقها للمنطقة الإقليمية. إعتمد منحني علاقة الكثافة مع السرع بإخراج دوال (8 مجسات) التي بينت معدل المنحنيات لعلاقات السرعة الزلزالية والكثافة والتي توافقت مع منحني(Nafe and Drake). أنتج المعكوس الجذبي تمثيل الشواذ الجذبية بدالة الكثافة والسرعة الذي يدخل بنظر الإعتبار في معالجة التسجيلات الزلزالية الإنعكاسية وتحويلات القياسات

*Email:sirhasan@yahoo.com

الزمنية الى عمقية كعامل جيوفيزيائي مُكمل ومعلومة مضافة لمعلومات الآبار المحدودة في المنطقة الإقليمية
من العراق. وتم الحصول على نتائج جيدة تتعلق بتفسير المقطع الزلزالي المعتمد في منطقة الدراسة.

1. Introduction

The study of mapping and understanding geodynamic processes like deformations of the Earth's surface and its interior mass structures often related to global change, still in the consideration of the scientists and push them to develop the theories and all related aspects, [1].This research is focused on the following gravity related topics in the regional central area of Iraq. Most seismic exploration studies that blocks indicated at the mid and southwestern parts of Iraq, which usually carried blind interpretation of velocity model exporting, due to poor oil well drilled and bad quality of seismic surveying recorded [2].

The integration of geophysical data survey and taking this poor well data as the control point will be very useful to resolve at less the background of suppose structural and stratigraphy model, [3].The gravity is as the self potential method, which presented indirectly good logical relation with fault systems, structural and basin models. The theory of the gravity method indicates that the gravity anomaly related to the density anomaly in the subsurface layers, [4]. It's better to avoid applying the residual windows of gravity Bouguer grid, because as this data was self potential will be better to analysis without synthetic control, [5].So the filter applying to the self potential data by the power spectrum analysis, which showing the nature depth layers affect in high and low amplitude by energy graduated curve, [6].

This research attempt regional area (Central and southwestern Iraq) Figure- 1 use the relation of density with velocity to achieved the inversion of gravity to density value model, then attempt in integrate the available data of gravity, seismic and well data to enhance the quality and interpretation depended of flow chart design based of the mentions raw data, Figure- 2.

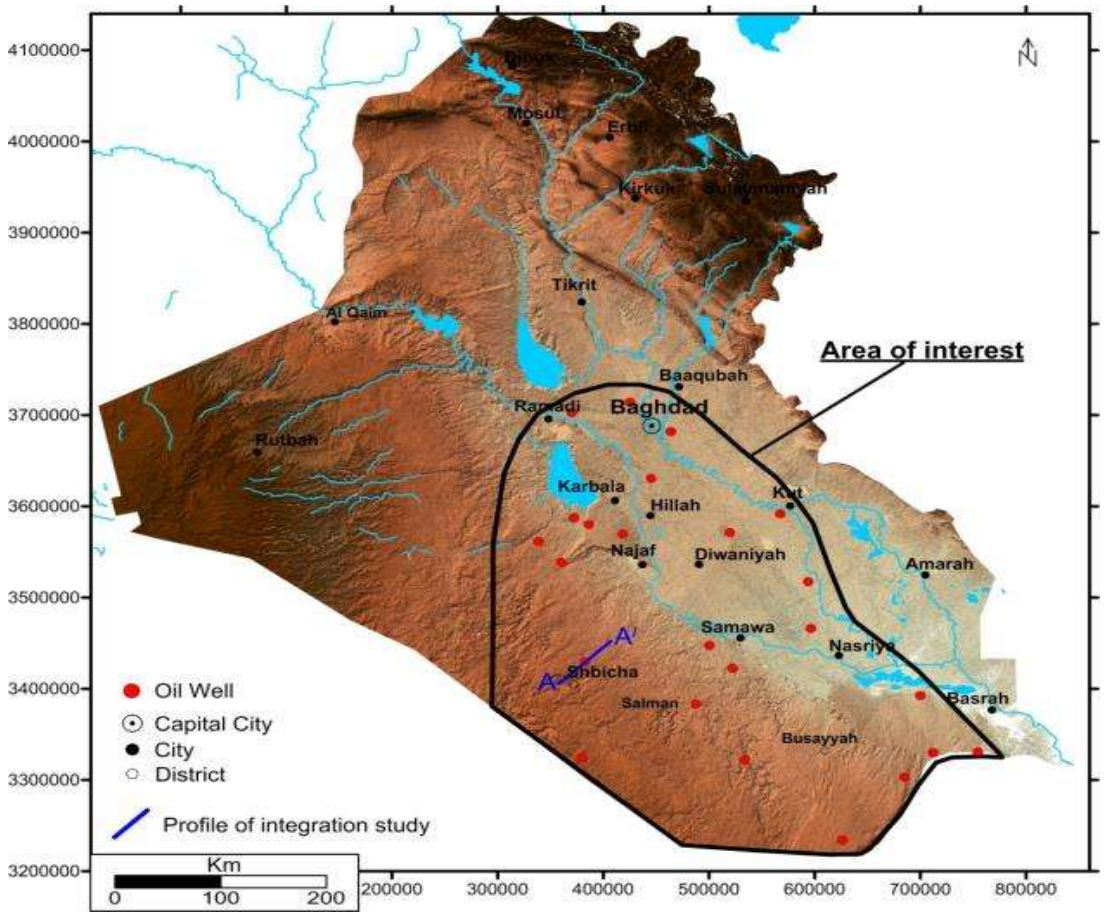

Figure 1-Showing the locations of regional study area include (24 Oil wells) which input to analysis density & velocity relation.

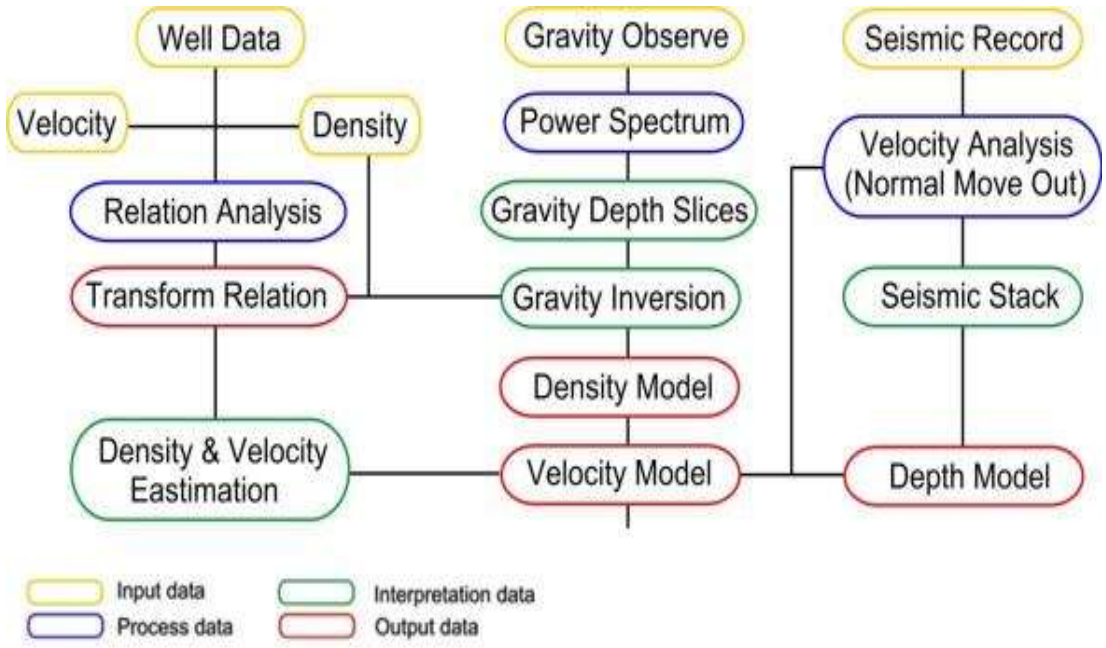

Figure 2-Flow chart of current geophysics integration based on (input data, processing, interpretation and output data).

2.Density & Velocity Relation Analysis

Regional study area include (24 wells) distributed evenly and having well velocity survey, (14 wells) having density logs. Presents the estimation of relation curve in regional area using function windows of the totals wells data reflects the velocity & density variables, calculating the average function for each well to present the relation curve only in well location which refers a positive function, Figures-(3, 4). Interpolated the total relation curve of the (14 wells), obtained relation with standard curves relations it found that (Nafe and Drake standard curve) is generally corresponds with the curve, Figure- 4. Adopted this relation for the other (10wells) in regional study area which having one logs only (Well velocity survey). Through this applying it covered the density formations value estimation in all (24) wells, Figures- (5, 6, 7).

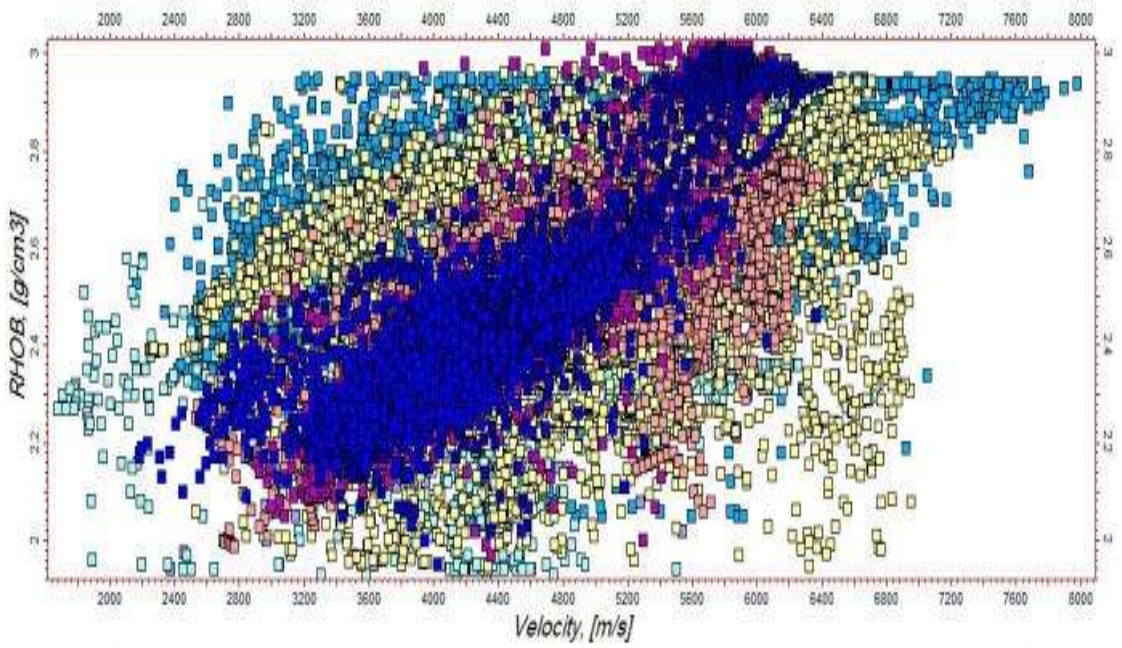

Figure 3-Function windows showing the scatter values of density & velocity relation along the borehole to total depth of (14) regional deep wells.

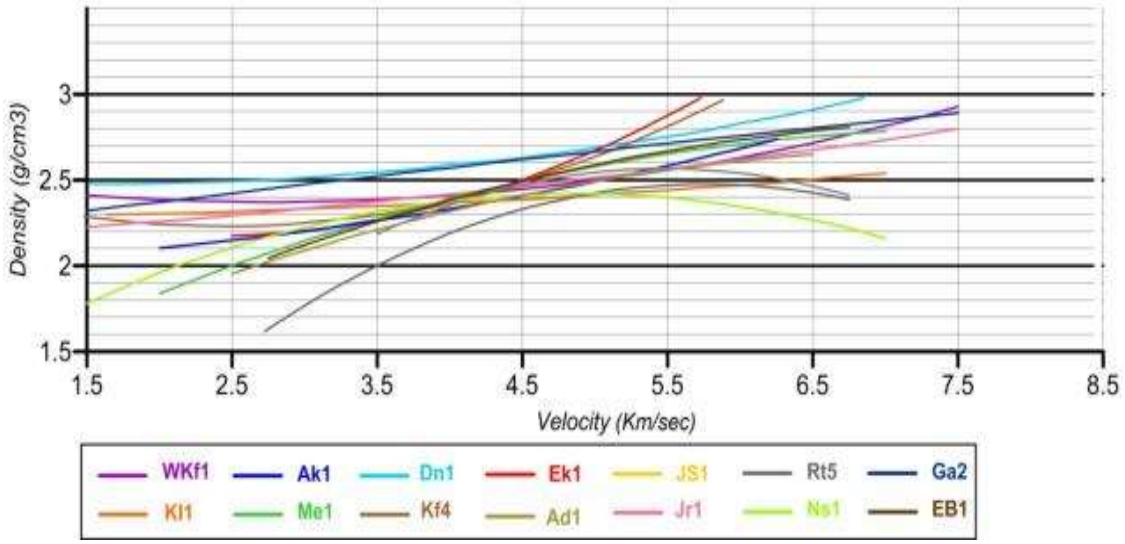

Figure 4-Relations curves to average of density & velocity along the borehole to total depth of (14) regional deep wells.

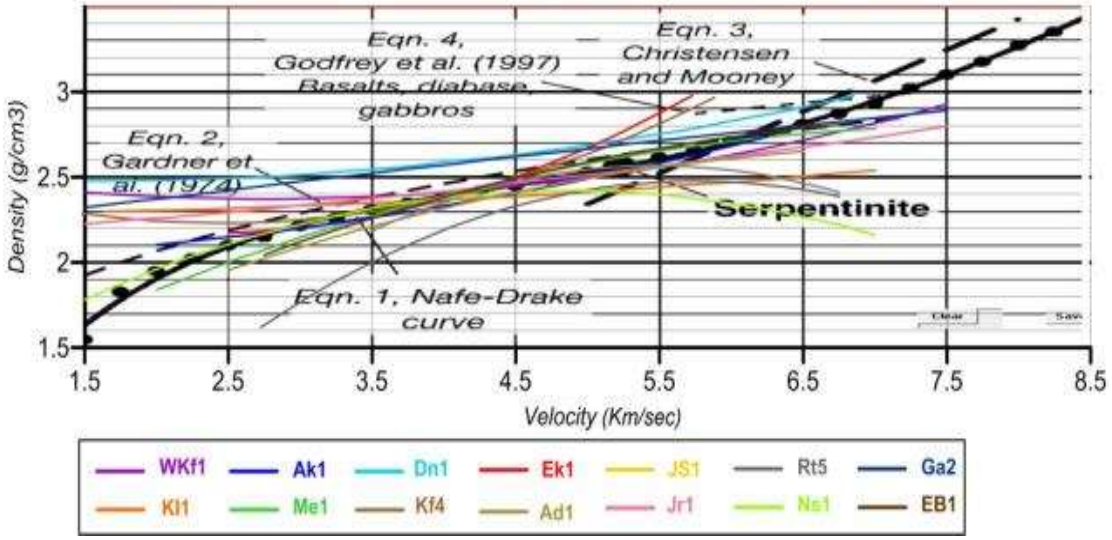

Figure 5-Compare relations curves (density & velocity) of (14) regional deep wells with standard curves Corresponds.

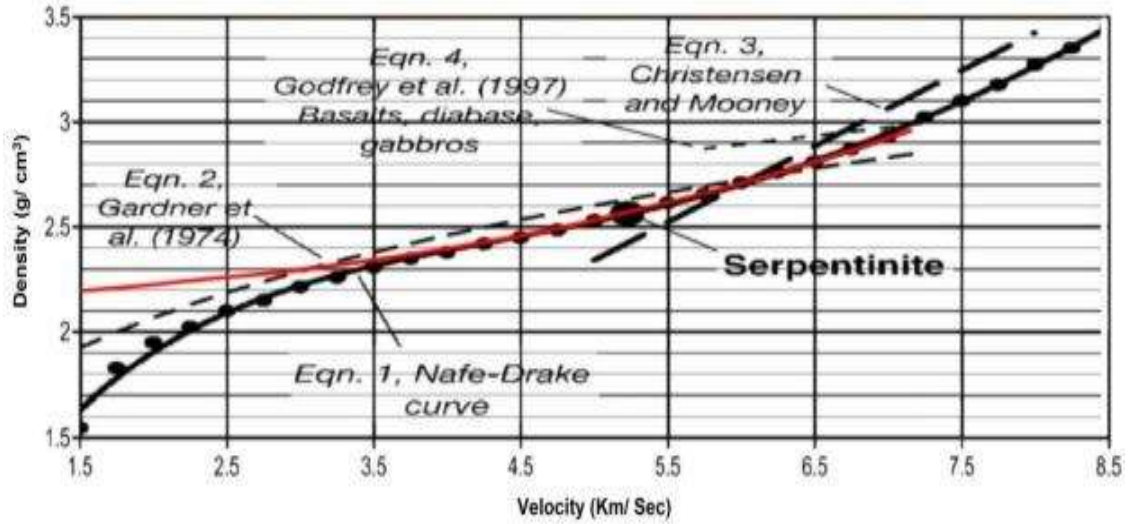

Figure 6-Shows the matching general behavior (density & velocity relation trend) of the average of total eight deep wells regional (red color curve) with Nafe and Drake standard corresponds trend, [7].

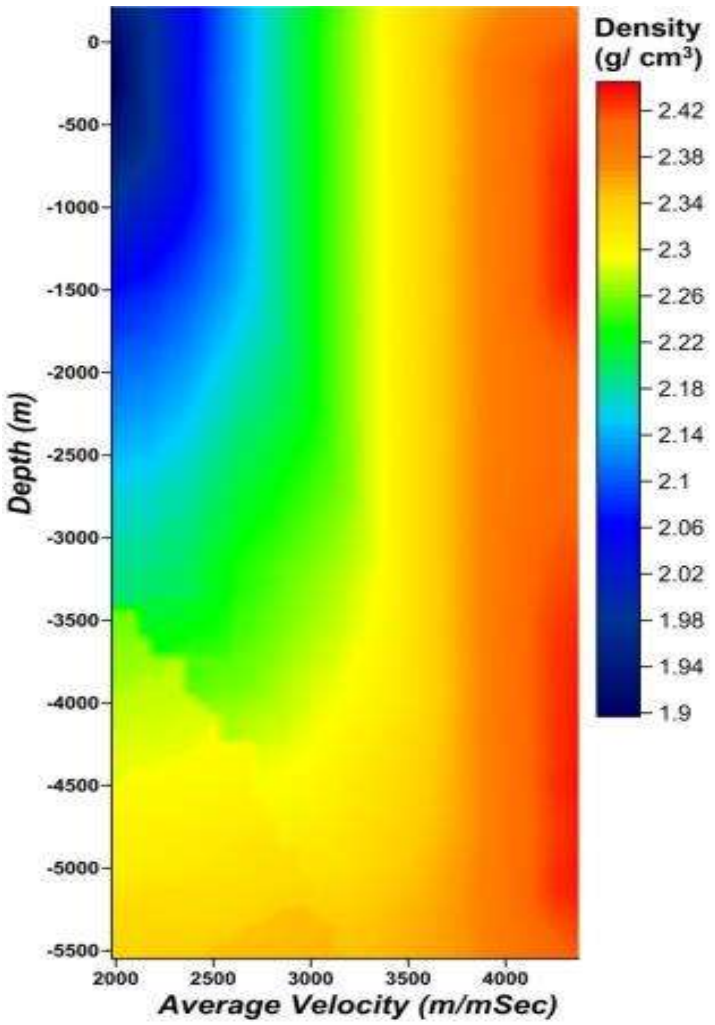

Figure 7-The density grid coverage from the scatter logs values in depth and velocity function of (24) wells in regional study area, shows the density behavior is divided into inhomogeneous distribution due to different environments laterally through depth levels.

3. Power Spectrum Analysis

Represent the gravity grid in high to low amplitude and frequency function with distance and depth that reflects the details of depth anomalies, [8]. Using *GET grid* software and load the gravity Bouguer grid and analyzing into spectral gradient through the functions of amplitude and frequency, Figure-8. Taking straight trend touches each part of spectrum curve; straight trend is the tilts of amplitude and frequency various, [9]. each slices straight gives depth anomaly level, the high amplitude energy with low frequency reflect deeper level and the low amplitude energy with high frequency reflect shallow level, [10].

According to this procedure the gravity Bouguer survey product the dominate anomalies effect from six depth levels;12900m, 9400m, 5290m, 2750m, 1910m and1100m, Figures-(9, 10).

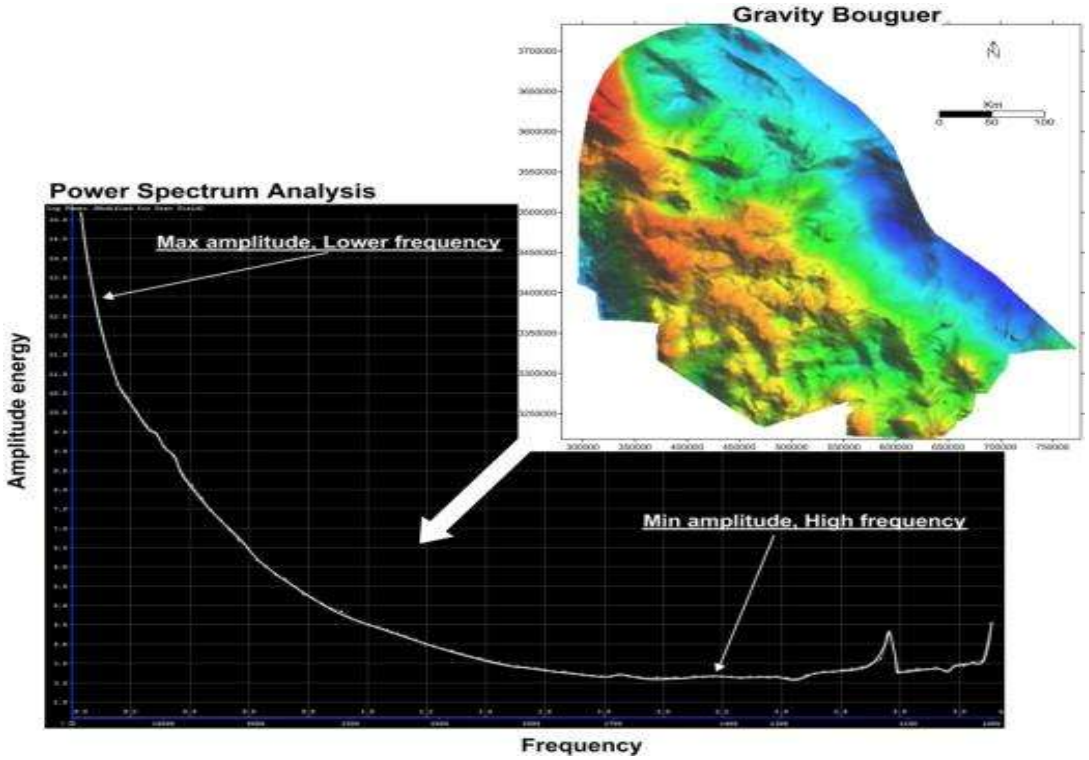

Figure 8-Power spectrum analysis of the gravity Bouguer, shows the spectrum of high to low amplitude and frequency.

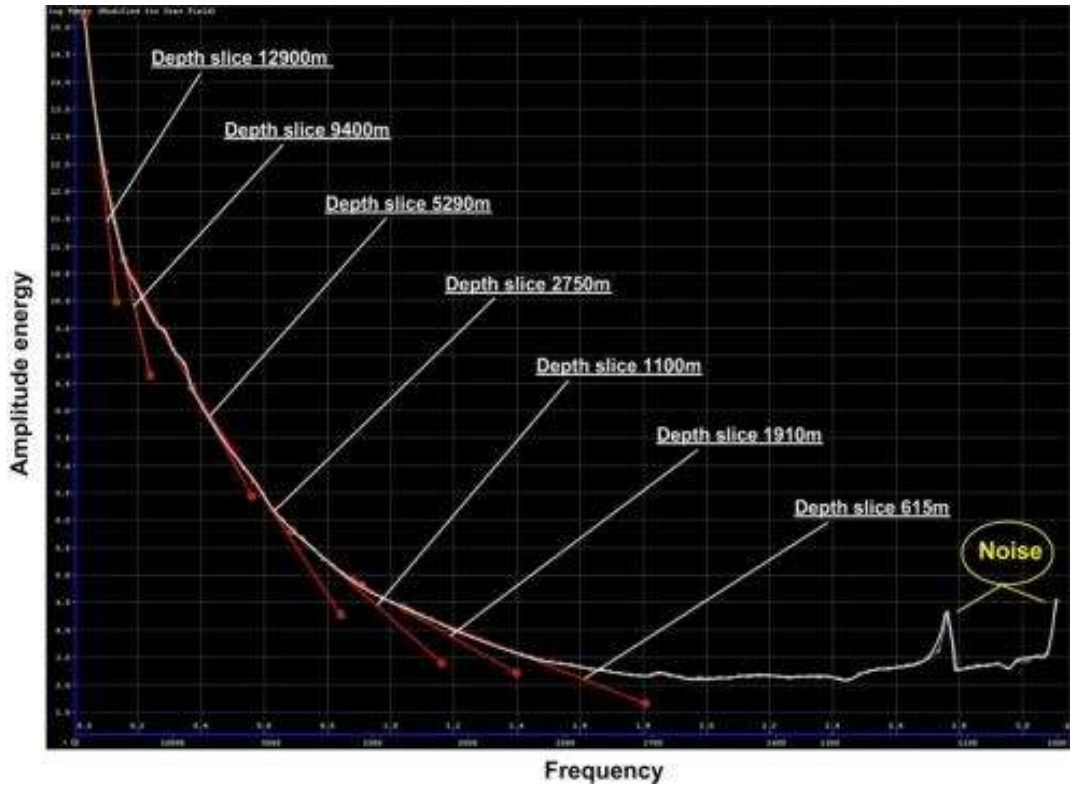

Figure 9-Power spectrum analysis of gravity Bouguer, present of the relative depth slices interference and shallow noise.

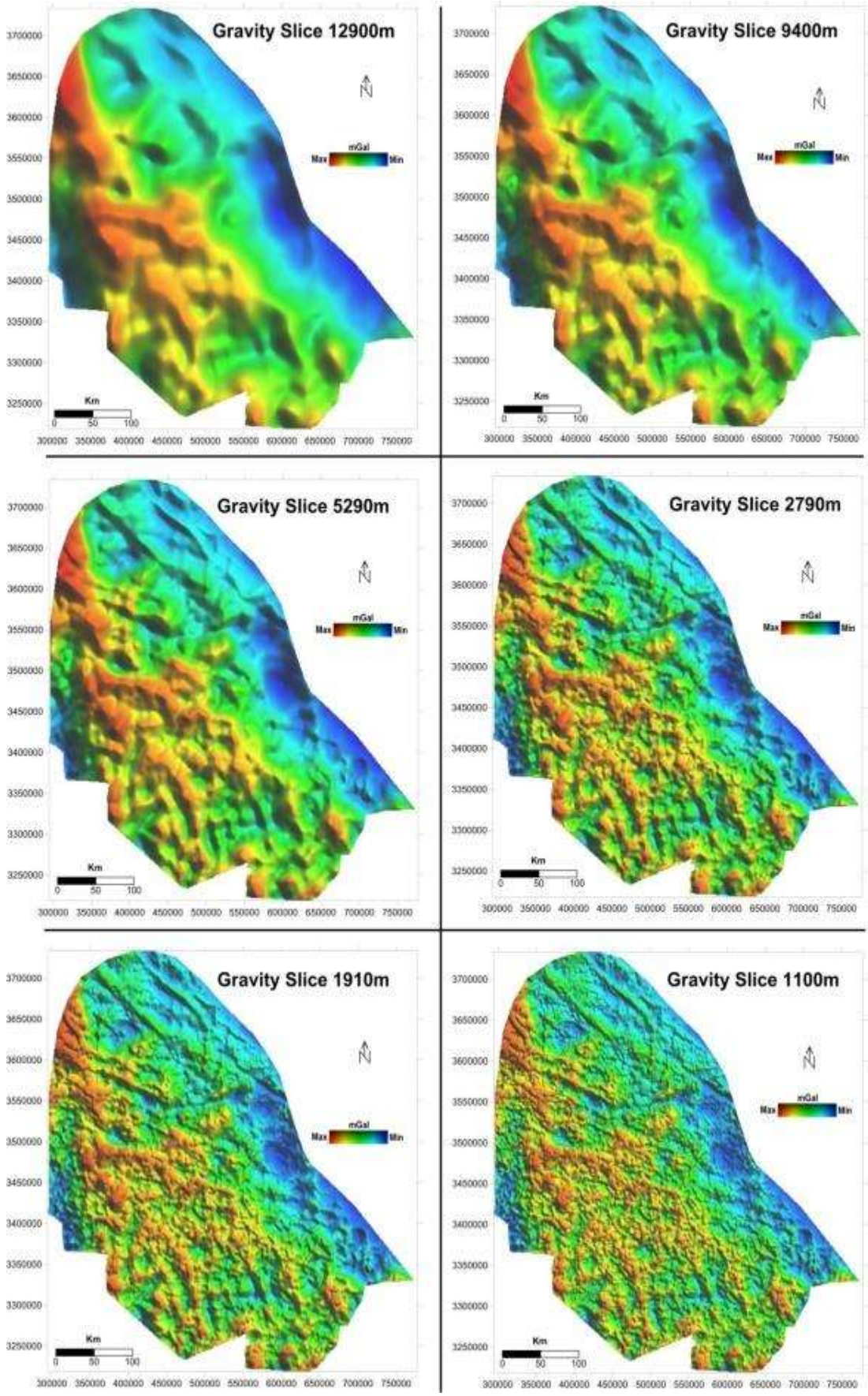

Figure 10-Showing the domination of grid levels interference in gravity domain, after applying the power spectrum analysis.

4. Density and Velocity Models

Spectral of depth slices in gravity domain, the well depth formations and their densities estimation from curve relation of density and velocity as mentioned have been data base of geometrical model. The idea of model design been putting the weight of each slice effective for four functions values: (Gravity, depth slice, mean density through the wells at the same slice and total depth of model), then simulate the wavelength of the trajectory path down to a precise match of the real density at the well site as a control point, [11].

The behavior of wavelength along profile is reflecting the density contrast laterally, by applying the procedure for all depth slices level in gravity domain, will get the density contrast vertically and horizontally distribution, Figure-11. The output of the proposal density model considered the all geological formations along the gravity profile recorded. From the output density model it can export any layer and present to density domain include windows (5290m) as the maximum depth level of deepest well. The procedure applied by fast Fourier transforms (FFT), after to quality control the density estimation of the profiles passing through the wells; will been ready to converting into velocity function by *(Nafe and Drake standard curve conversion),* It produced the acoustic impedance model as a result of multiplying the scatter values of density by velocity, which it useful to indicate the evaluation of subsurface basins and structures, Figures- (12, 13).

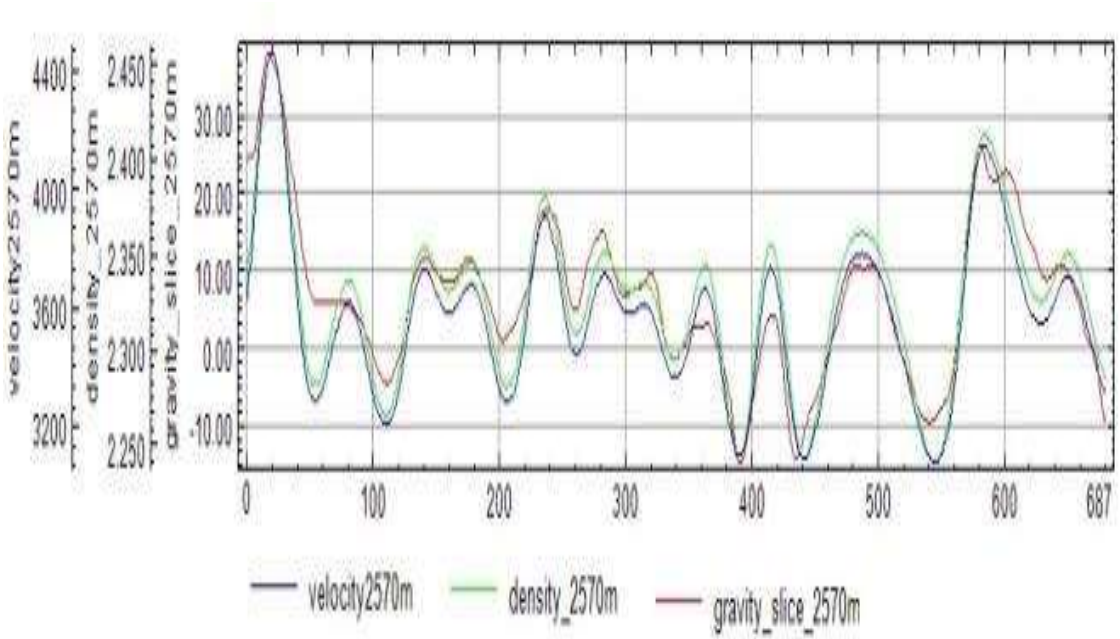

Figure 11-Spectral of depth slices in gravity domain inverted to density and velocity domain.

5. Geometrical (3D) Modeling

The scatter value of density and velocity along to all grid profiles has been interpolation or simulated to continuous data throughout the model grid. Deterministic (estimation or interpolation) and stochastic methods are available for the distribution of continuous properties, geometrical modeling is the process where properties can be generated by using pre-defined system variables, such as cell volume, surface slices resample, zone index, etc. Each cell will get a numerical value corresponding to the selected system variable, object modeling allows populating a discrete facies model which are generated and distributed stochastically. By presenting the five slices at to depth (5290); will been exported 3D velocity cube in segy format (Society of Exploration Geophysicists), which propose to consider the lead tools in processing the seismic reflection recording and time to depth domain conversion, Figures- (14, 15).

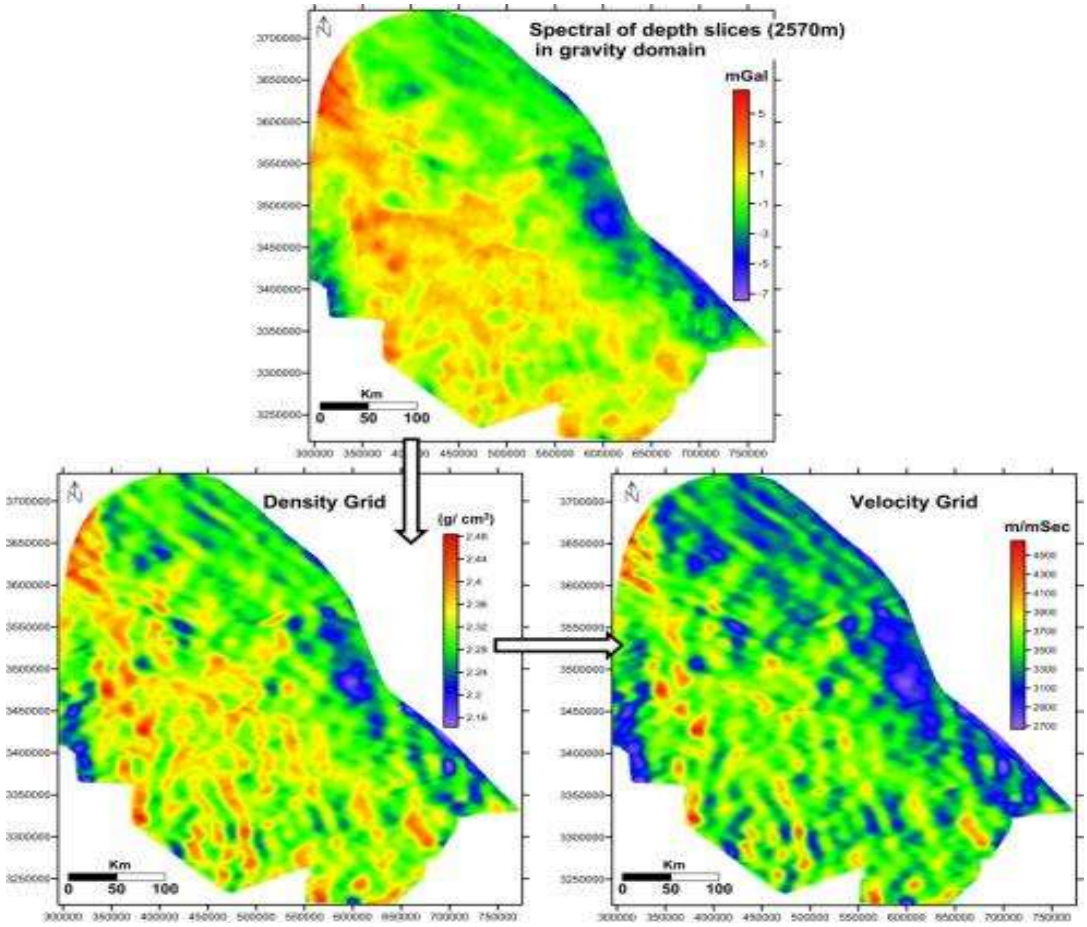

Figure 12- Showing the gravity inversion applying in 2D grid that biuld from (FFT Transform) to the profiles values of spectral depth slices in gravity domain to density and velocity domain.

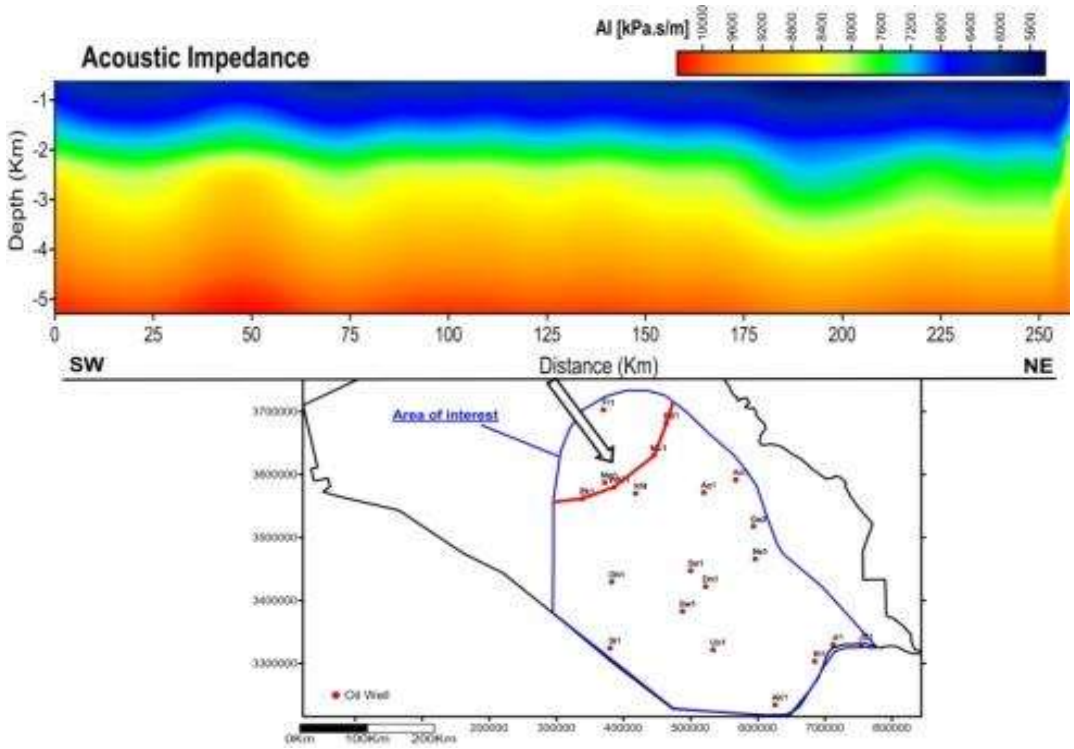

Figure 13-Showing the acoustic impedance profile model as a result of multiplying the scatter values of density by velocity, passing at the dip direction of the regional area (NE – SW).

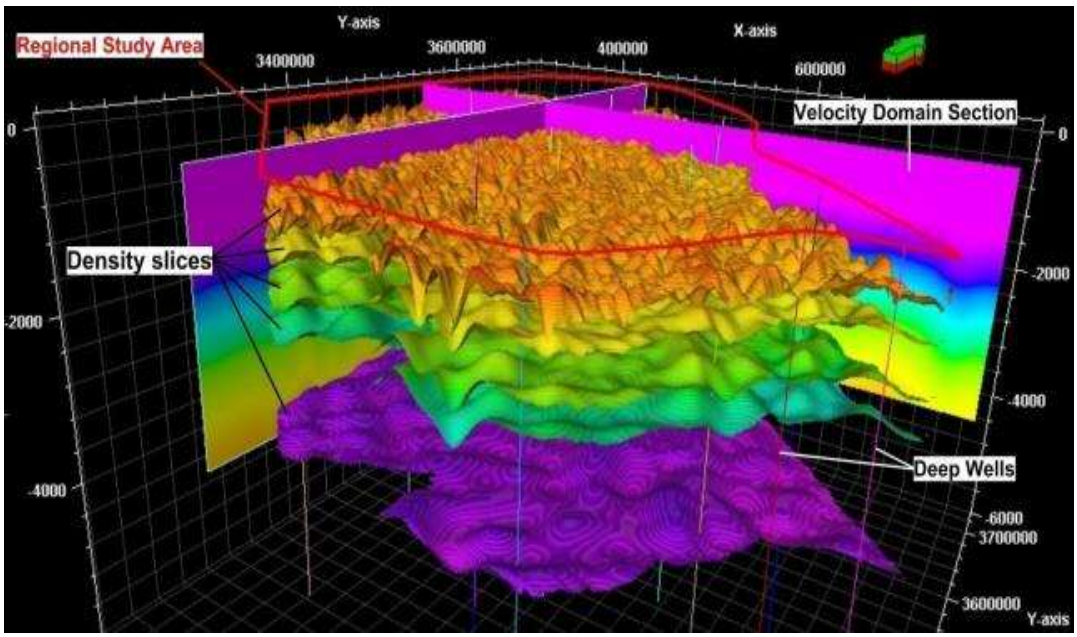

Figure 14-3D grid model in depth domain including the density surfaces slices through the section crossing of velocity model at the regional area of interest in central Iraq.

Relatively the density of sediments increases with depth but density contrast decreases with depth,[12].

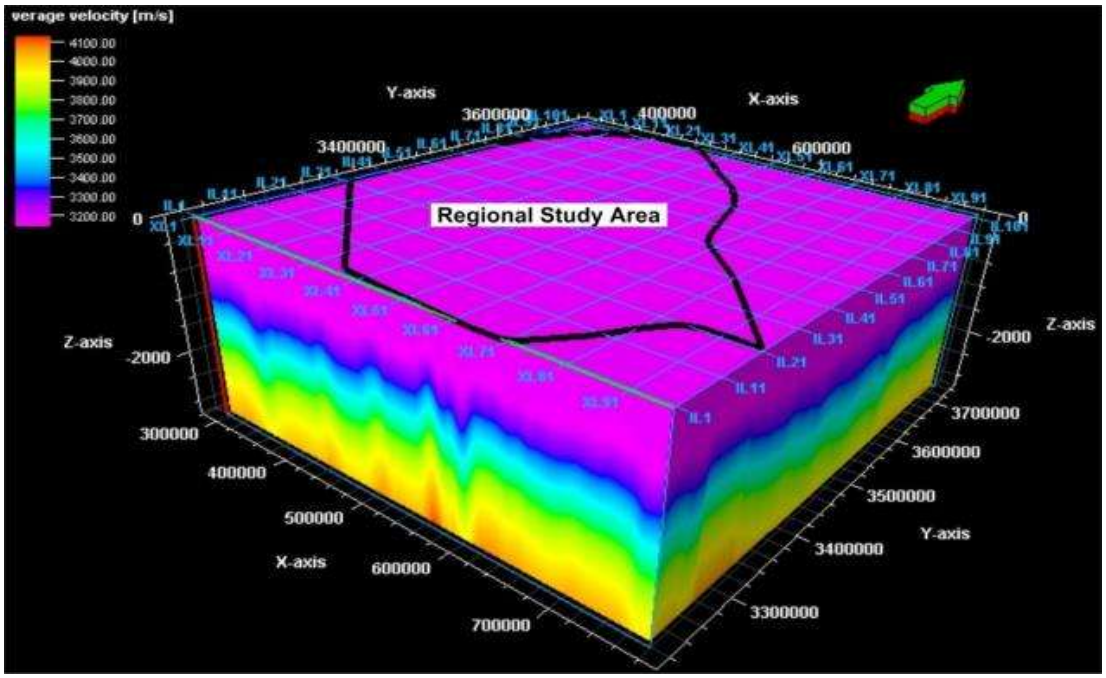

Figure 15-Showing 3D velocity cube (as segy format) in depth domain designed by conversion the 3D geometrical model to the velocity inverted from the gravity spectral slices.

It has been takes sample of the new seismic record to locate within Al- Najaf desert in southwestern Iraq, were at the same path exactly of the new gravity survey profile recorded by space interval (250m) along (70Km). compared between the two velocity models; it notes the average velocity model which extracted from gravity carries better stratigraphy means than RMS velocity model which extracted from seismic processing, Figure-16.That shows through the grid simplicity and velocity distribution in the two models for a total depth around (2000m), Figure- 17.

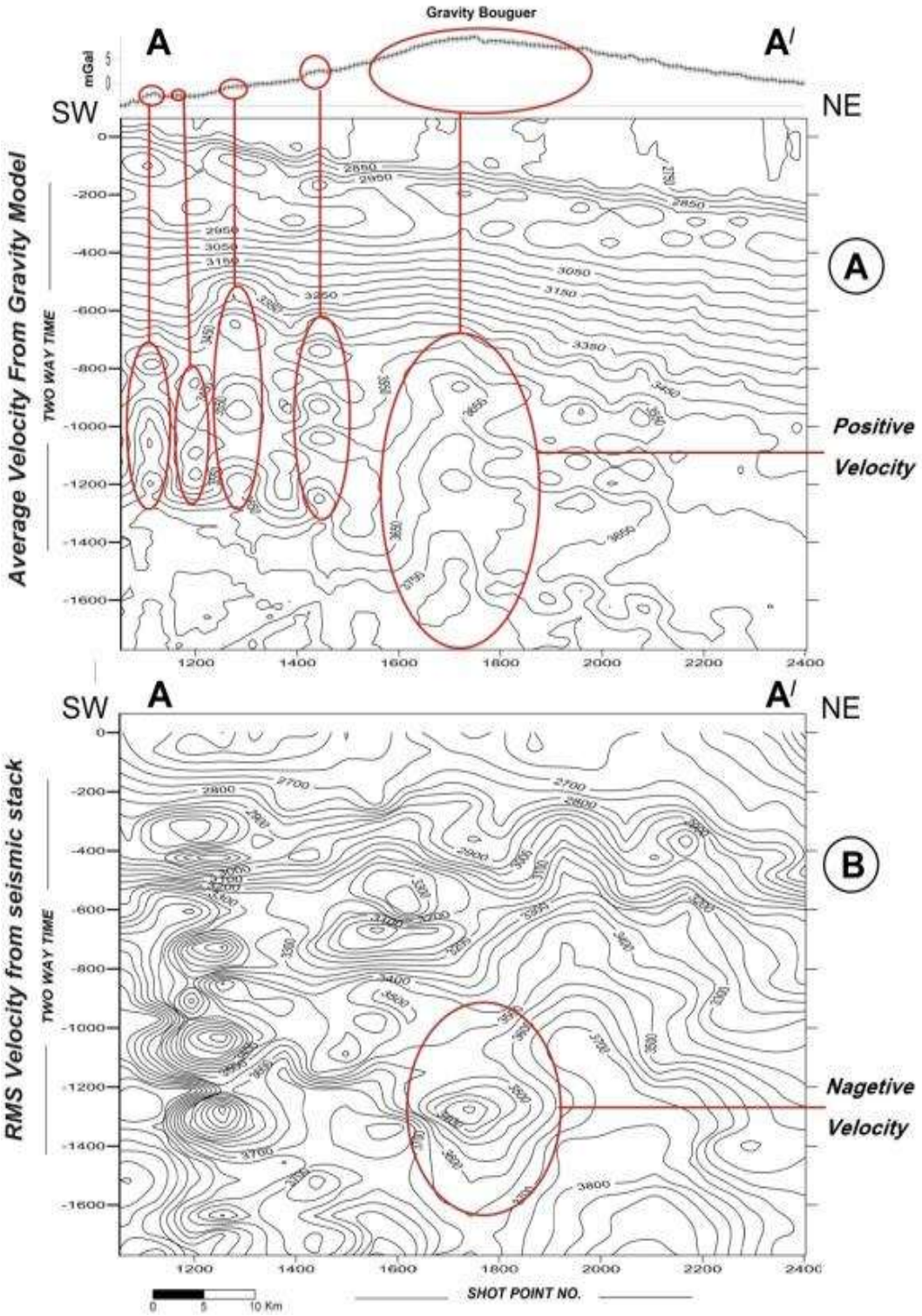

Figure 16-Compare the velocity model at seismic line between the average velocity estimated from gravity survey and RMS seismic processing velocity, shows the effective of big & small elements of gravity anomaly reflects positive velocity.

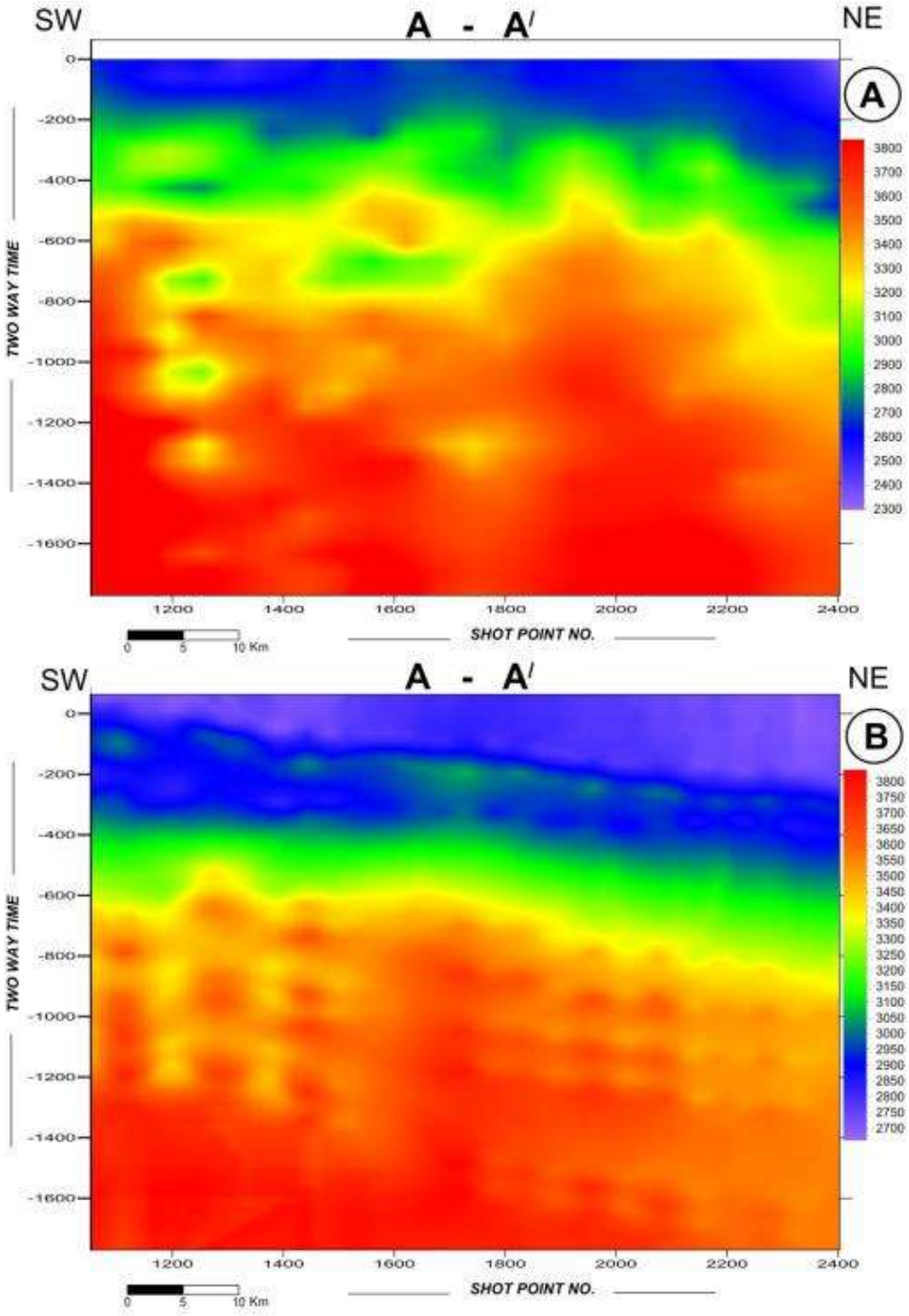

Figure 17-Compare the velocity distribution grid at seismic line (7Gn- 16) between (A) RMS seismic processing velocity and (B) average velocity estimated from gravity survey. (B) Carries better stratigraphy means and obtains reverse velocity in shallowest level.

The processor user applied average velocity estimated from the gravity; showed clear enhancement in improved seismic signal recorded than applied RMS velocity, especially in fault location and representation as showing in (Figures- 18, 19, 20). It's applied in seismic velocity process as the QC of

velocity model [13] which inverted from gravity indirectly; this technique considered to first trying taking in Iraqi oil Exploration Company (OEC).

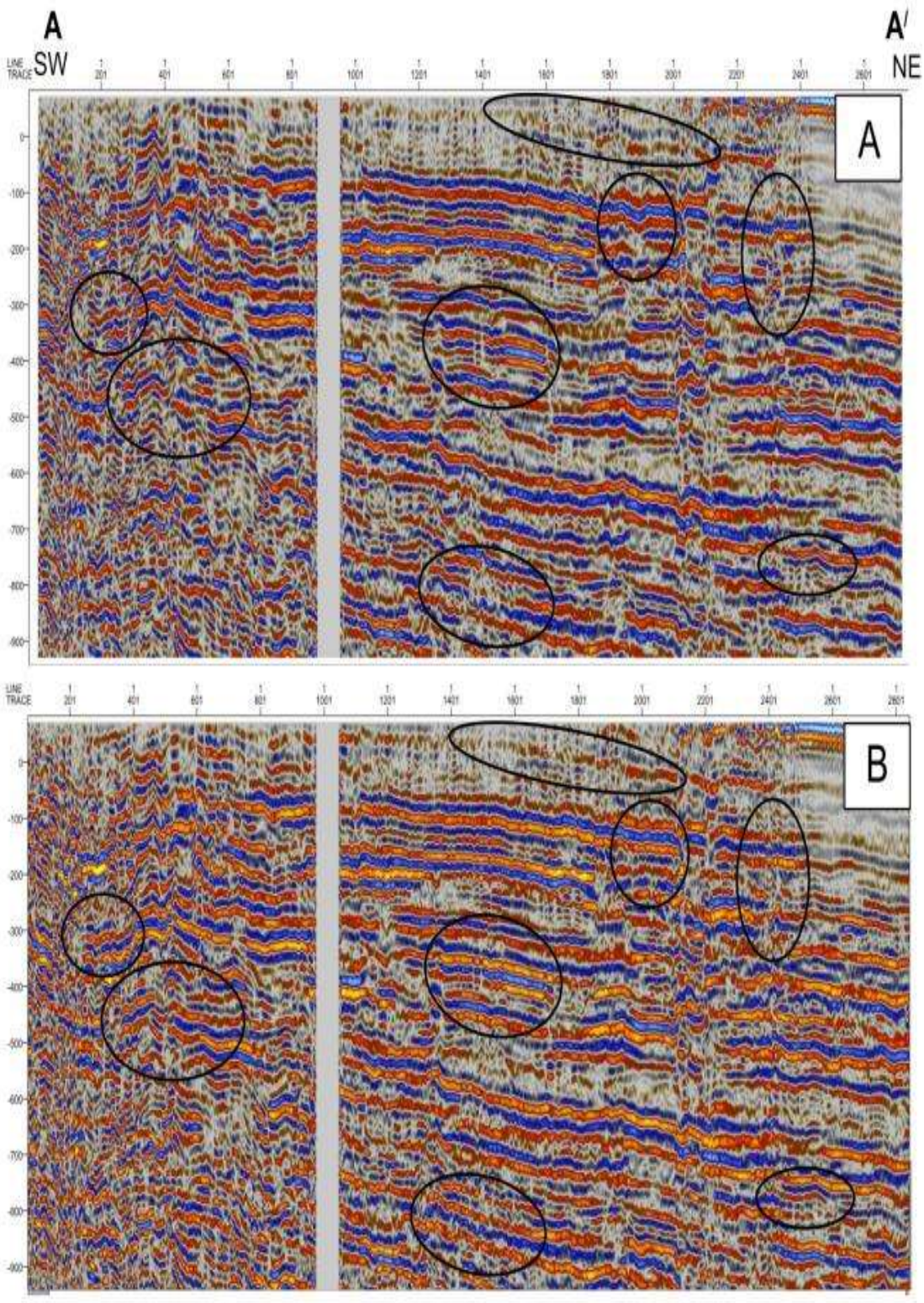

Figure 18-Shows seismic lines (7Gn- 16) compare it the results of seismic processing by apply the RMS (Present A) and by apply average velocity estimated from the gravity survey (Present B), the general enhancement reflectors foxed in black polygon.

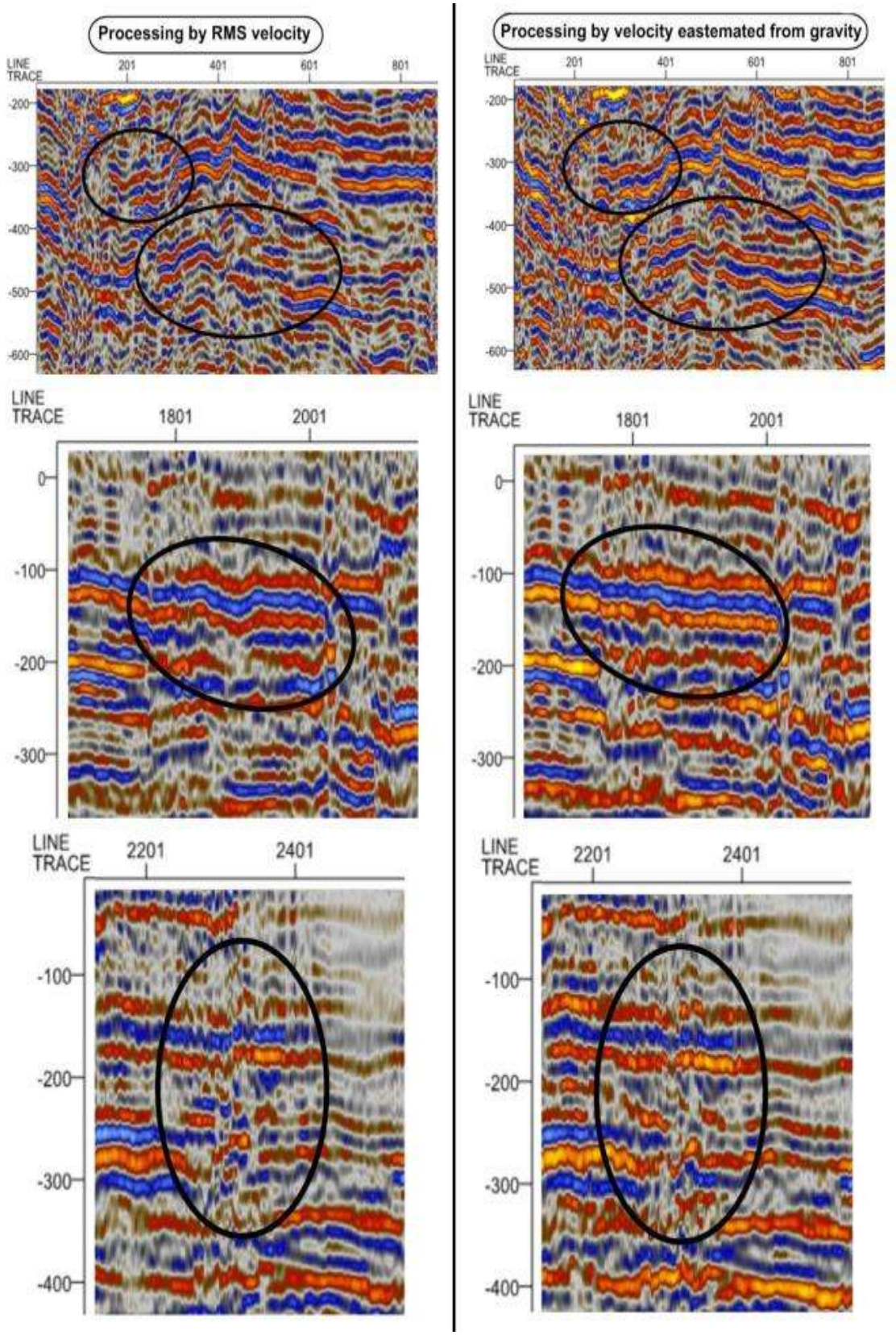

Figure 19-Shows the clear enhancement in improved seismic signal recorded that effective by the fault & fractures diffraction within seismic line (7Gn- 16) after applying average velocity estimated from the gravity survey.

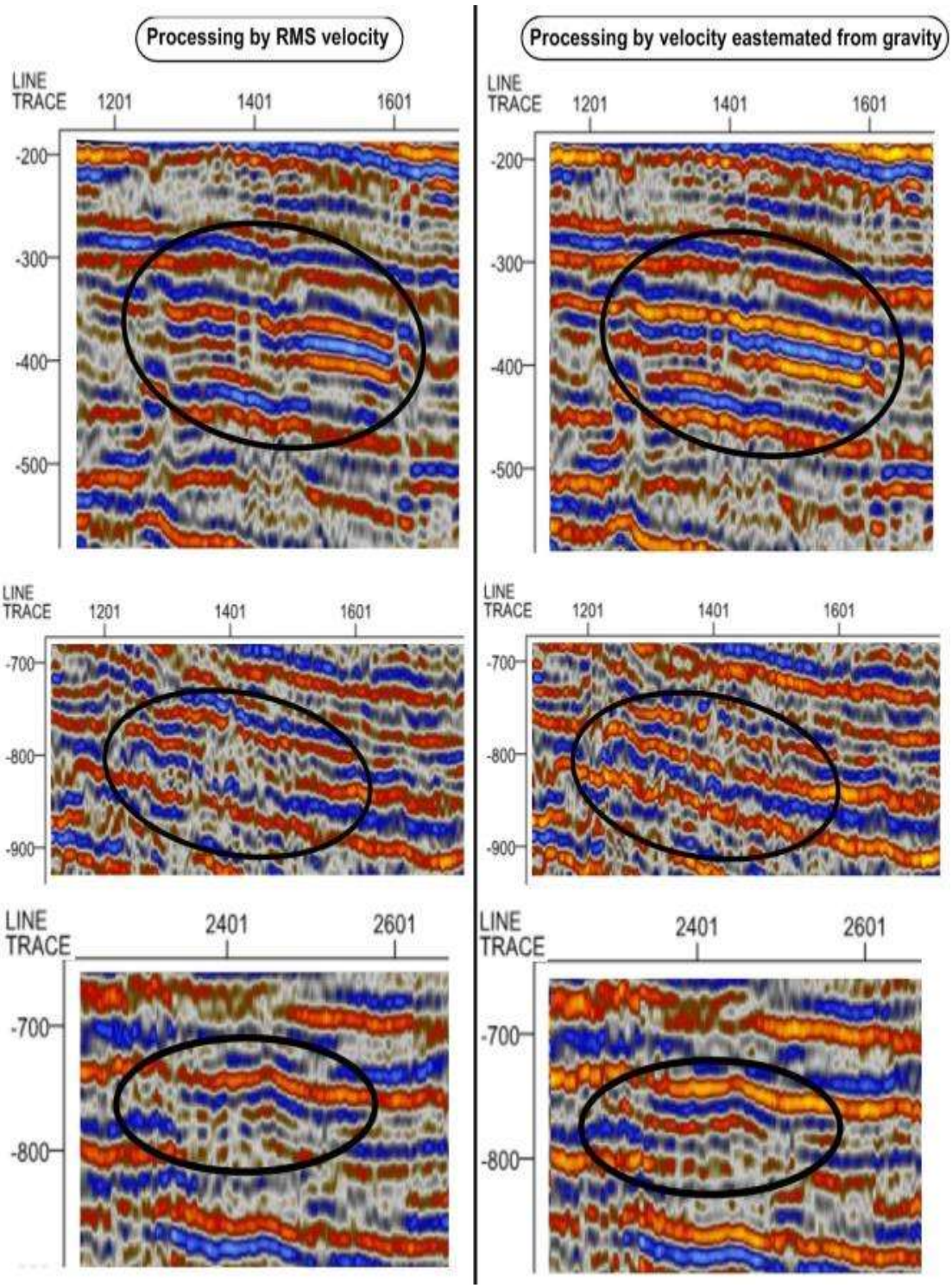

Figure 20-Shows the clear enhancement in improved seismic signal recorded that effective from the noise wave, by applying average velocity estimated from the gravity survey than applied RMS velocity, foxed within seismic line (7Gn- 16).

Average velocity from gravity model which it used to enhancement the seismic section process has been best velocity to convert time to depth, after transform to depth domain the horizons keep on the continuity with distance and without distortion or interference with each other in depth domain as were in time domain, Figure- 21.

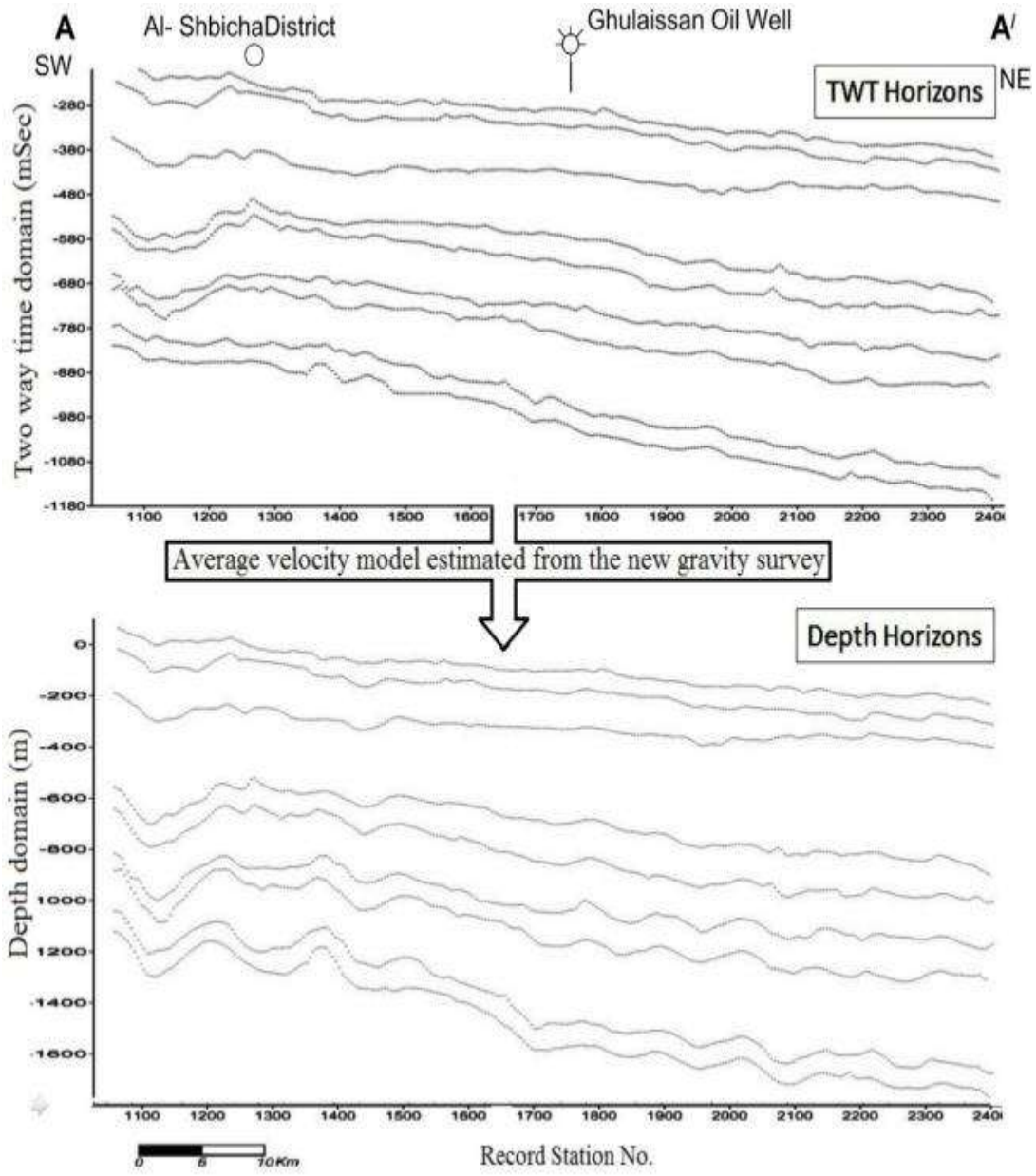

Figure 21-Conversion the time horizons from time to depth domains by average velocity model estimated from the gravity survey, shows the top formation surface kept its behaviors in depth domains indicating the logical velocity model applied.

6. Conclusions

The current study which it based at the geophysical raw data with new applications for integration concepts, showed the following: _

1. Power spectrum is the tool to analysis the main underlying levels that reflect the gravity anomaly level and not to estimate the depth values directly.
2. Estimation the density model from gravity values means gravity inversion based at well density data as the start and QC point to distribution the density levels, as well based to the geometrical model (Total depth of model, number of levels and their depths).
3. The current research produce relation transform between (Density & Velocity) covered regional area from central Iraq which corresponds generally in standard curve of Nafe and Drake.
4. The average velocity model (extracted from gravity) carries better stratigraphy means than stack velocity model (extracted from seismic processing), The most QC of the credibility of supposed velocity model is into applying to seismic processing again, that obtain the clear enhancements in

seismic reflectors when use velocity model (extracted from gravity) specially in places of diffraction effect from the fault & fractures and in the noise wave effective (odd wave).

References:

1. Sjöberg, L. E. and Bagherbandi, M. **2017**. *Gravity Inversion and Integration*. Department of Industrial Development. University of Gävle, Sweden.
2. Mazeel, M. A. **2010**. Hydrocarbon reservoir potential estimated for Iraq bid round blocks. Institute by Wood Mackenzie Upstream Service, Ministry of oil, Iraq Country.
3. Bornatici, L., **2011**. Regional integrated interpretation central North Gulf of Mexico. *SEG San Annual meeting*, **42**: 2334- 2338.
4. Carigali, G. **2004**. *Geophysical Surveying Using Gravity*. Kursus ES304-Geophysical Prospecting.
5. Blakely, R. J., **1996**. *Potential Theory in Gravity and Magnetic Applications.* Cambridge University. The Edinburgh Building. Cambridge CB2 2RU, United Kingdom.
6. Chamoli, A., and Dimri, V.P. **2010**. *Spectral Analysis of Gravity Data of NW Himalaya*. National Geophysical Research Institute. (CSIR), Hyderabad, India.
7. Nafe, S.E. and Drake, C.L. **1963**. *Physical properties of marine sediments*. In: Hill, M.N. (Ed.), The Sea. Interscience Publishers. New York.
8. Maus, S., and Dimri, V. **1996**. *Depth Estimation from the Scaling Power Spectrum of Potential Fields*. National Geophysical Institute. Hyderabad.
9. Barbour, A. J. and Parker, R. L. **2015**. Normalization of Power Spectral Density estimates. *Computers & Geosciences Research*, **34**: 51-68.
10. Jacoby, W. and Peter L. Smilde, P. L. 2009. *Gravity Interpretation: Fundamentals and Application of Gravity Inversion and Geological Interpretation*. Springer-Verlag Berlin Heidelberg.
11. El-Khadragy, A., Azab, A. A. and EI-Khafeef, A. A. **2014**. Contribution to the Integrated Interpretation of Gravity, Aeromagnetic and Seismic Data of the Northern and Central Parts of Sinai, Egypt. *World Applied Sciences Journal*. **31** (9): 1540-1551.
12. Getech, G. plc. **2011**. *Reprocessing, Compilation & data basing the aeromagnetic and gravity data of Iraq, aeromagnetic and gravity data of Iraq*. Kitson House, Elmete Hall, Elmete Lane, Leeds, LS8 2LJ, UK..
13. Horscroft T. R. and Bain, J. E. **2015**. *Validation of Seismic Data Processing and Interpretation with Integration of Gravity and Magnetic Data*. LCT Ltd, 2nd floor, 83-84 George Street, Richmond, Surrey TW9 1HE, UK.