Using Multiattribute Analysis to Predicting Effective Porosity of Yamama Formation in Nasriya Oilfield Southern Iraq

Salman Z. Khorshid[1], Ghazi H. Al-Sharaa[2], Maha F. Mohammed[*1]

[1]Department of Geology, College of Science,University of Baghdad, Baghdad, Iraq.
[2]Ministry of Oil, Oil Exploration Company, Baghdad, Iraq

Abstract

Emerge application was used in Hampsson-Russell programs and that uses a combination of multiple 3D or 2D seismic attributes to predict some reservoir parameter of interest. In this research used the seismic inversion technique was performed on post-stack three dimensions (3D) seismic data in Nasriya oilfield with five wells and then used this results in Emerge analysis (training and application) were used to estimate reservoir properties (effective porosity) with multiattribute analysis derive relations between them at well locations. The horizon time slice of reservoir units of (Yb1, Yb3 and Yc) of Yamama Formation was made for property (effective porosity) to confirm match results and enhancement trends within these units. Because of the good prospects of the oil in the rocks of Cretaceous generally and Yamama Formation specially in the Nasriya oilfield and in view of the economic importance of Yamama Formation, which is considered as important formation that contains hydrocarbon accumulation, and one of the most important and oil production reservoirs in southern Iraq.

Keywords: Emerge, Emerge training, Multiple attribute and Emerge application.

أستخدام التحليل المتعدد الملامح للتبئا بالمسامية الفعالة لتكوين اليمامة في حقل الناصرية جنوب العراق

سلمان زين العابدين خورشيد[1]،غازي حسن الشرع[2]، مها فاضل محمد[*1]

[1]قسم علوم الأرض، كلية العلوم، جامعة بغداد، بغداد ، العراق

[2] وزارة النفط ، شركة الاستكشافات النفطيه ، بغداد، العراق

الخلاصة

استخدم تطبيق Emerge في برامج الهامبسون-رسل ويستخدم جمع عدة ملامح زلزالية بالابعاد الثنائية او الثلاثية للتنبئا ببعض المعامل المكمنية المهمة. في هذا البحث تم استخدام تقنية المعكوس الزلزالي حيث تم العمل على بيانات زلزالية ثلاثية الابعاد بعد النضد لحقل الناصرية مع خمس ابار واستخدمت هذا النتائج في تحليلات الـ Emerge (الاختبار والتطبيق) لتقييم المواصفات المكمنية (المسامية الفعالة) مع تحليل الملامح المتعددة واشتقاق علاقة بينهما في مواقع الابار. الشريحة الزمنية لعواكس الوحدات المكمنية (Yb1, Yb3 and Yc) لتكوين اليمامة تؤكد تتطابق نتائج مواصفة (المسامية الفعالة) والتحسن في الاتجاهات ضمن هذة الوحدات. سبب الاحتمالات الجيدة للنفط في صخور العصر الطباشيري بصورة عامة وخاصة لتكوين اليمامة

_____

*Email:maha.fadel@yahoo.com

في حقل الناصرية ونظرة واهمية اقتصادية لتكوين اليمامة، ويعتبر تكوين مهم لاحتواء على التجمعات الهايدروكاربونية، وواحد من المكامن الاكثر اهمية والمنتجة للنفط في جنوب العراق.

1. Introduction

Nasriya oilfield is located in southern part of Iraq within the Dhi Qar governorate about 38 km north-west from the Nasriya city (Figurer-1) Nasriya structure was discovered in 1975 through a seismic investigations covered partially the southern part of Iraq by (I.P.C.) groups [1]. The current study is achieved working on the 3D seismic survey. These survey where done in 2012 [2]. The two main types of data that used are seismic data and well data, to predict reservoir property. The aim of study is to using seismic attribute analysis to produce a reservoir characterization volume for effective porosity by using Emerge analyses. It worthily the studied oilfield is located in the southern part of Iraq. The structural configuration of the field is gentle NW-SE trending anticline approximately 35 km long and 21km wide (Figure-2).
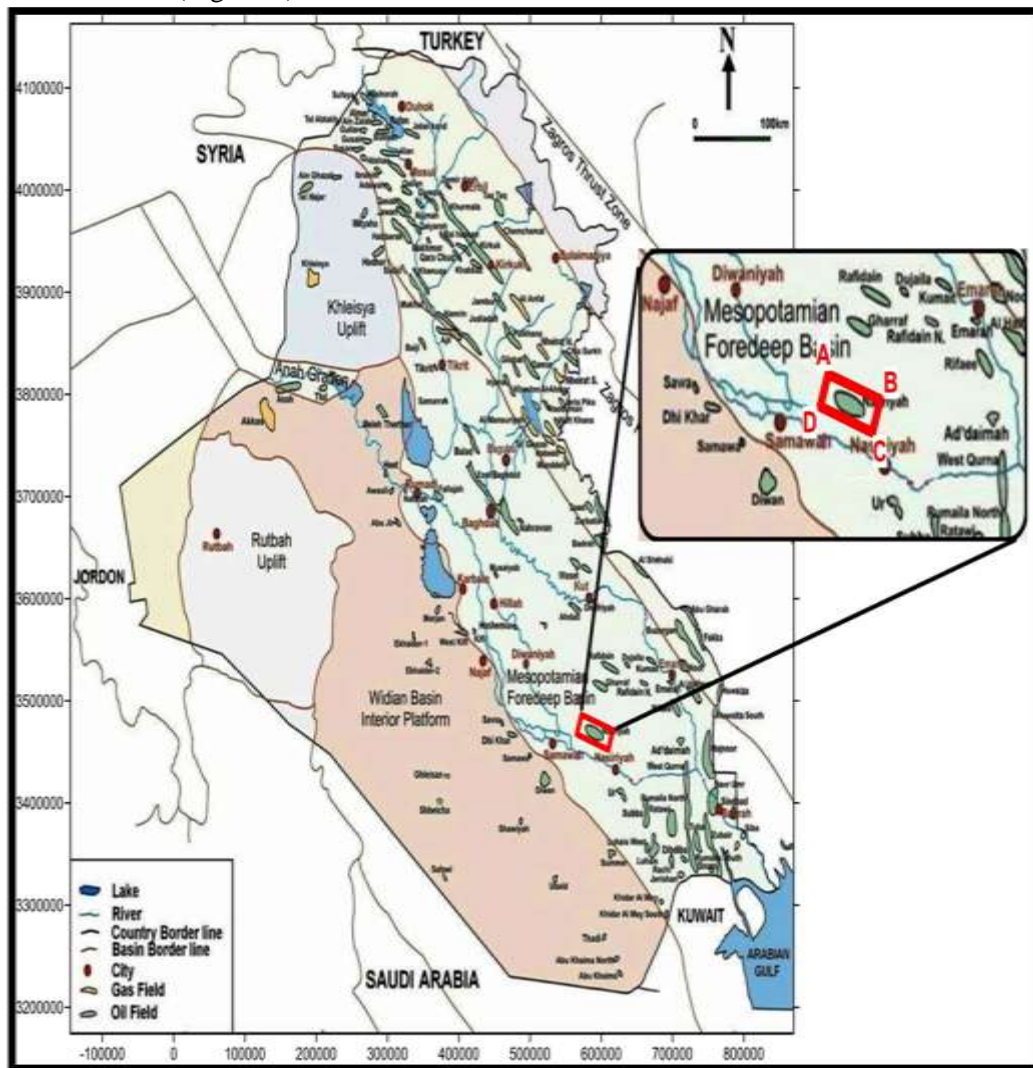

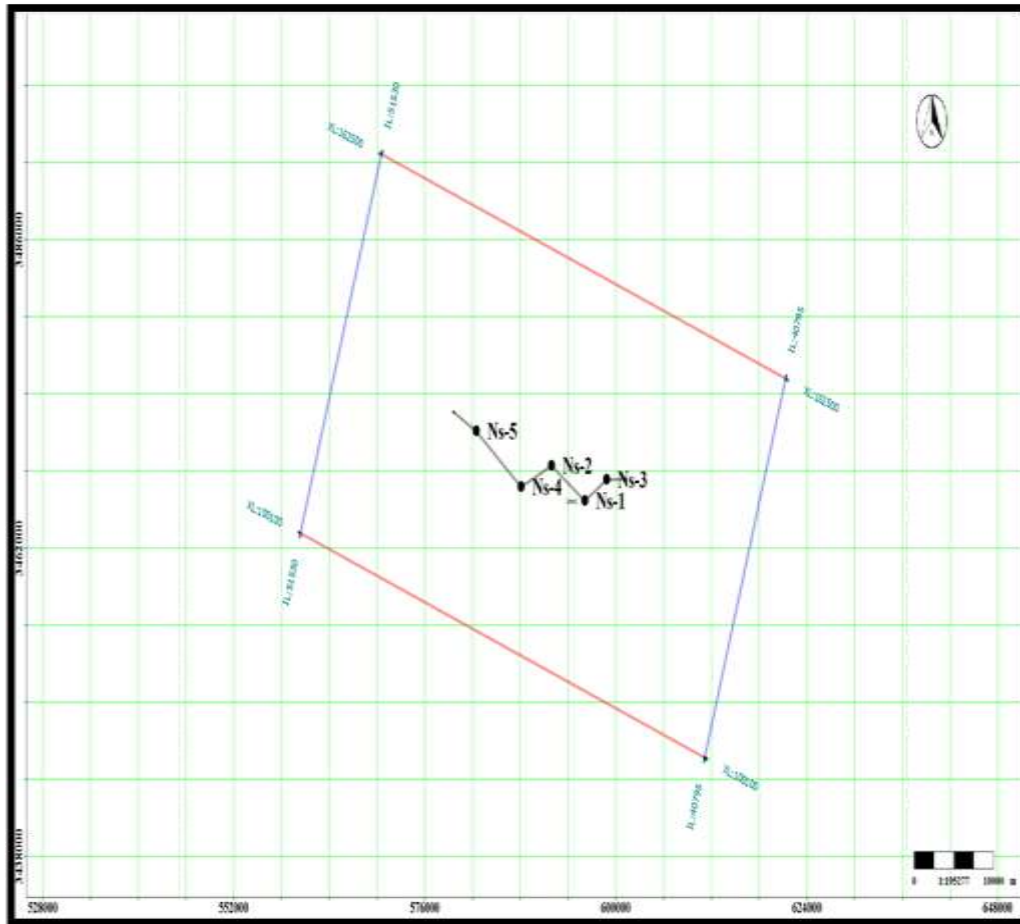**Figure 1-**Location map of the study area Modified from Al-Ameri, (2010) [3]

Figure 2-shows the base map of the study area and five wells location

2. Geologic setting

The Nasriya oilfield lies on the Unstable Shelf at the Mesopotamian basin according to the tectonic zones of Iraq [4] (Figure-3). This setting has a direct effect on structural style, fracture intensity and depositional setting.

Tectonism has played an important role in shaping the final configuration of the Yamama basin, and the Yamama basin extends over different tectonic zones. The western part of the basin is situated within the stable shelf of the Arabian Platform (specifically the Salman subzone of that belt), and the eastern part of the basin is located within side of the unstable shelf, the Mesopotamian foredeep [5]. The dividing of Yamama Formation Based on information from the core description and the thin section analysis done on the previously determined contact between the Ratawi and Yamama Formations that the so-called unit YA-1 consists of silty sandstone and siltstone [6]. This is opposite to the criteria used by [7], for differentiating between the two formations. Accordingly, the contact was slightly lowered below this unit and the top of the Yamama Formation consequently has been delineated on the first downward appearance of a relatively pure carbonate below the shale and the argillaceous limestone of the Ratawi Formation. The new contact was then traced in all the studied wells. Yamama Formation grades upward (conformably) into the Ratawi Formation which is consider the cap rock of the Yamama reservoir [5]. Divided Yamama Formation into three reservoir units; (YA ,YB ,YC), in this study its defined as (YR-A, YR-B, YR-C) and two barriers units YA1, YA2,is defined in this study as (YB-1, YB-2) [6].
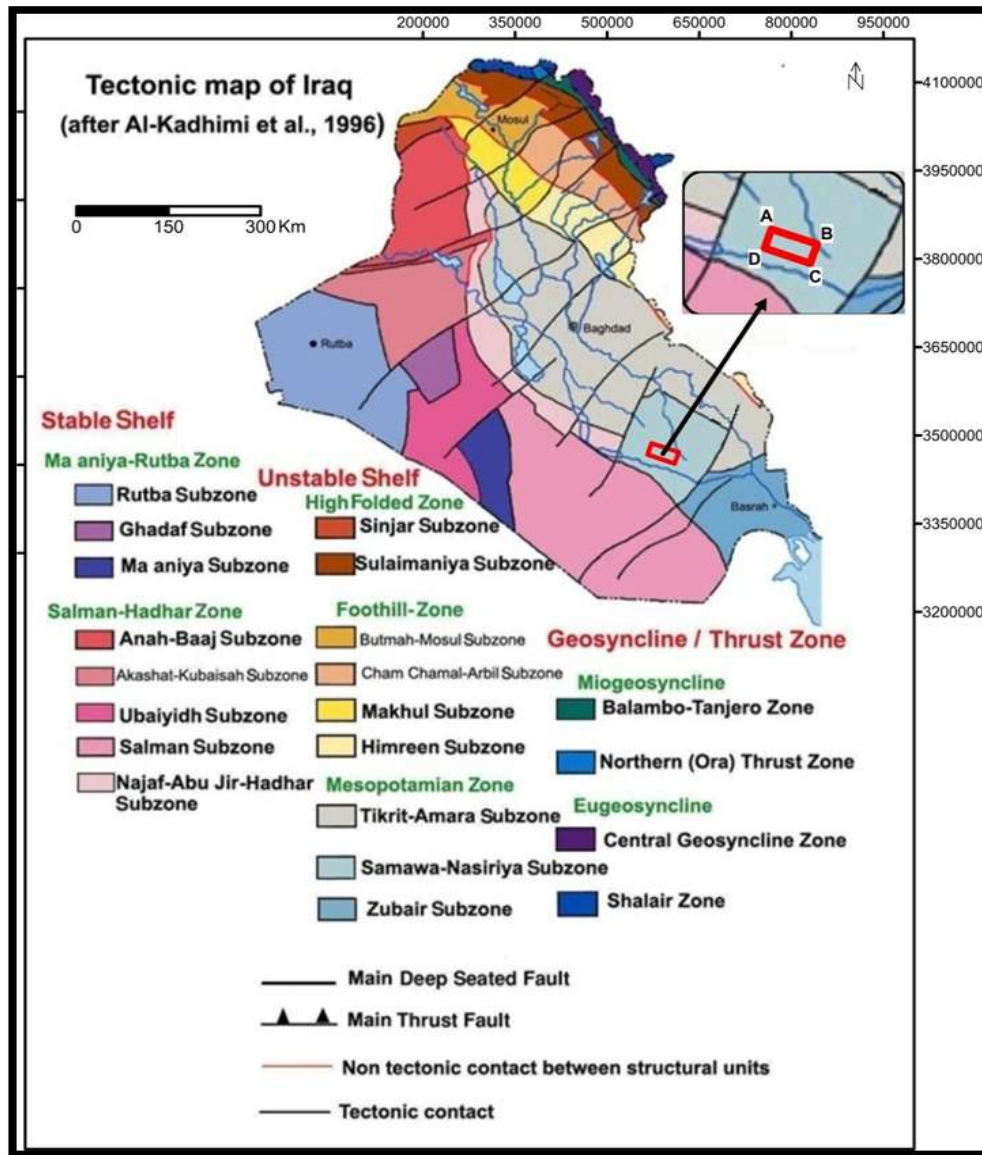
Figure 3-Tectonic map of Iraq [4].

3. Emerge

EMERGE is a module by Hampson-Russell Software Ltd., The Objective of the module is to analyze well log and seismic data at well locations using a variation combination of single attribute, multiple attributes and neural network. The module finds a relationship between the log and seismic data at the well locations to estimate and mapping seismic attributes to wells and reservoirs parameter of interest that can predict rock property volumes using both well and seismic data, which depend on the effectiveness of how well the selection of attributes can estimate the log property and how accurately the neural network can be trained [8].

Although relationship have been inferred between these attribute and reservoir parameters, the physical fundamental is not always clear and they proposed deriving statistical rather than deterministic relationship. This approach, which call a data-driven methodology, is summarized in the flow- chart in (Figure -4) [9].
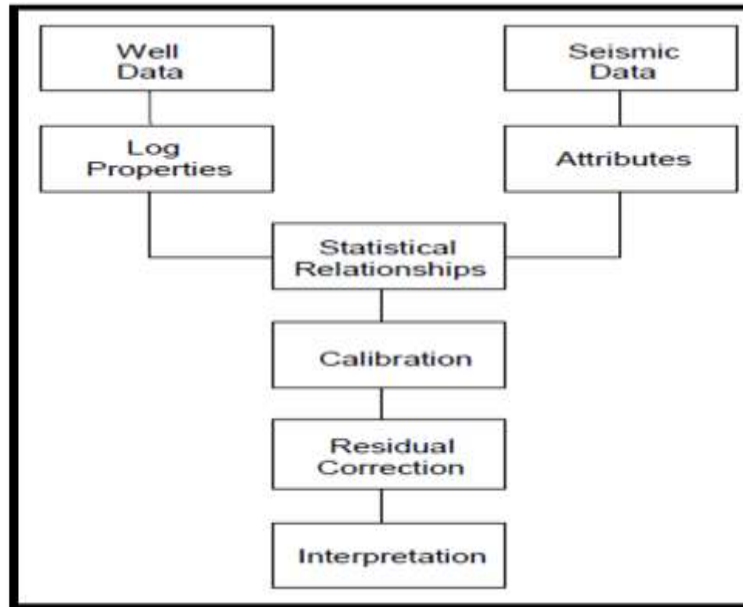
Figure 4-The data driven statistical interpretation [9].

4. Emerge training (testing)

The emerge model have two steps, the first step is the training and the second is the application in the testing stage by emerge module as integration tool which include three steps: single attribute, multiple attribute and neural network. The module analyzes the target log and seismic data at the well locations to derive a statistical relationship between them (Figure -5). This relation will be used later to predict the log properties over 3D seismic volume. The loaded data in current study that necessary to estimate effective porosity properties over the seismic study area. The effective porosity data included seismic data, computed P-wave and inverted volume (Figure -6).
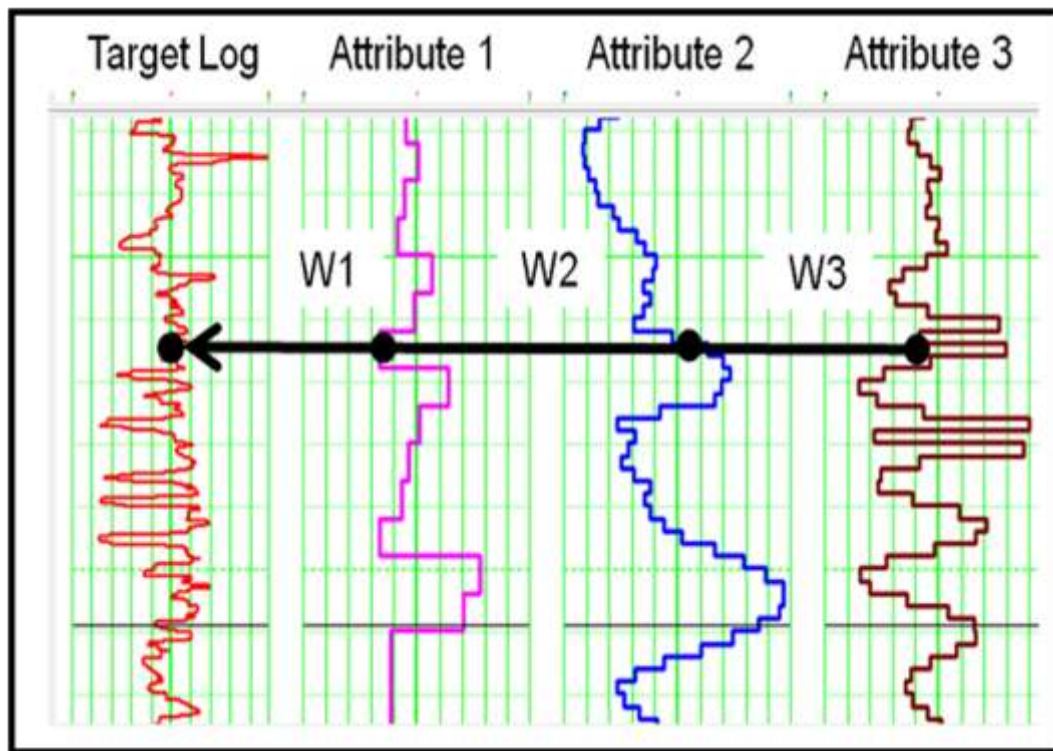

Figure 5-Show analytic window for attributes and target log at each point [10].
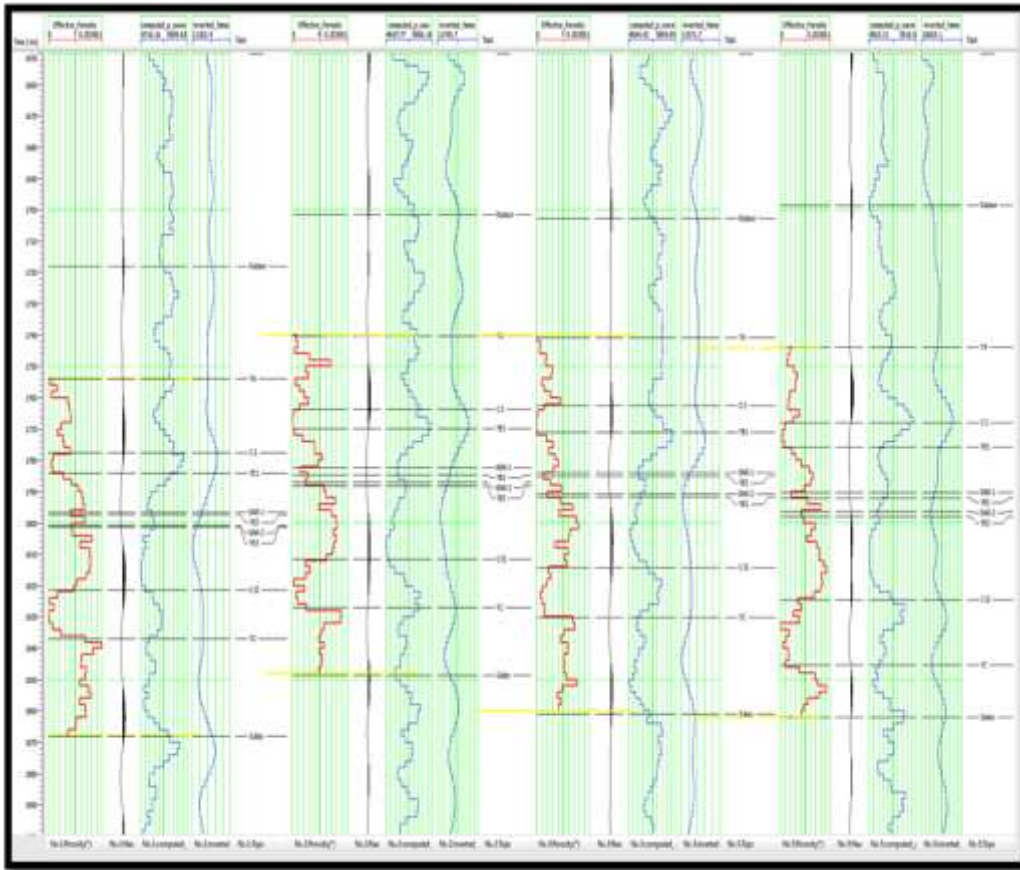
Figure 6-Data required to estimate effective porosity property, effective porosity log in red, seismic trace in black, P-wave and inverted in blue to the four wells in the study area.

5. Multiple attribute

Emerge can analyze and use several attributes to predict one variable, by using multivariate geostatistics, which include two approaches search methods that can be used to select the best attributes, and the Operator Length concept. Emerge uses a much faster, though less rigorously optimal, process called Step-Wise Regression [11]. This means that it finds the best single attribute, then the best pair of attributes, then the best triplet of attributes,… etc. At each stage, the criterion for deciding the "best" group is based on the RMS prediction error, i.e., the best group is the one that estimates the target logs with the least RMS error. To save analysis time, for the determination of each attribute group, emerge assumes that the first part of the group has already been found in the previous stage. In the current study using multi attribute analysis to determine the reservoir properties of the Yamama Formation in the Emerge application, were several attribute were used(the internal attribute of emerge and two external attribute the P-wave and inversion) , and target logs for effective porosity. In the first step of training to building emerge module the data that emerge uses:

3D seismic volume was taken as internal attribute while inverted volume was taken as external attribute. To improve the result multi attribute analysis was carried out which try to discriminate subtle features on the target logs.

In the first stage, target log and seismic data were analyzed to derive a statistical relationship between them. In the second, application stage, the derived relationship was applied to the entire volume to create log values

Throughout the seismic volume. A validation test was carried out to check whether the neural network and multiple attribute performed well.

One way of measuring the correlation between the target data and any one attribute, is to cross plot them. Four wells effective porosity log were used to perform the statistical analysis and found relation between logs and seismic attributes and select the most reliable ones using cross-validation for all logs to prediction overall volume.

Effective porosity was taken as targets for training and prediction from seismic amplitude and acoustic impedance data by emerge module. The module is applied using the inverted 3D acoustic impedance data as external attribute and compare it with 3D seismic data and the well data to create relationship in well locations through using internal algorithm provided in it.

The result training of the multiple attribute for effective porosity is Cross-plot validation error graph which estimate the better algorithm (statistically best fit attributes) correlated predicting effective porosity to remove the others of the training which increase error, validation results for this analysis shown in (Figure -7).

In (Figure -7) multiple attributes analysis used for effective porosity estimation in right hand (three attributes) and validation graph in the left hand that clear attributes out from the training. The lower (black) curve shows the error calculated using the training data and the upper (red) curve shows the error calculated using the validation data. So only the attributes before red arrow will be used.
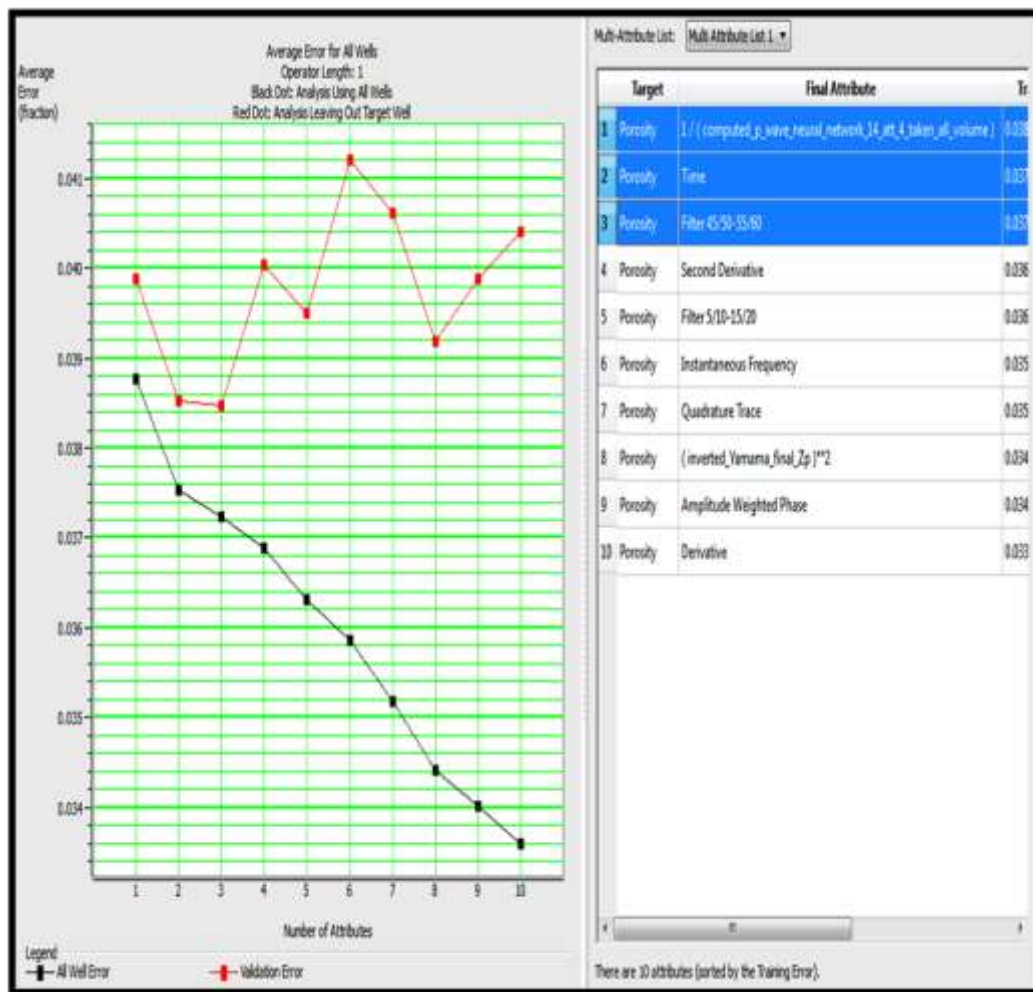

Figure 7-Cross plot shows the average error for the best three attributes used for effective porosity estimation.

Besides acoustic impedance, P-wave and effective porosity, the following attributes where used (1/computed _ p_ wave _ neural _network, time, and Filter 45/50-55/60), which were determined by emerge module within multi-attribute analysis, and improve the correlation coefficient 0.71 between actual and predicted effective porosity Figure-8.
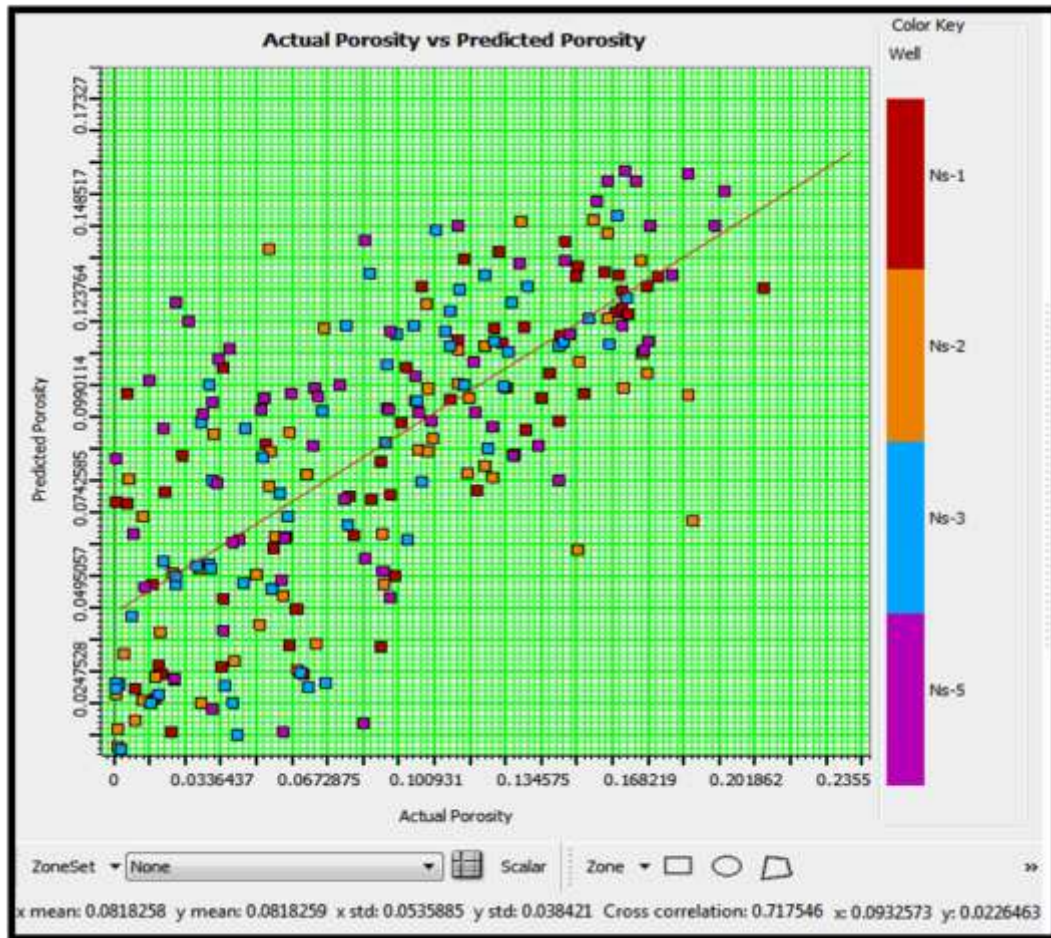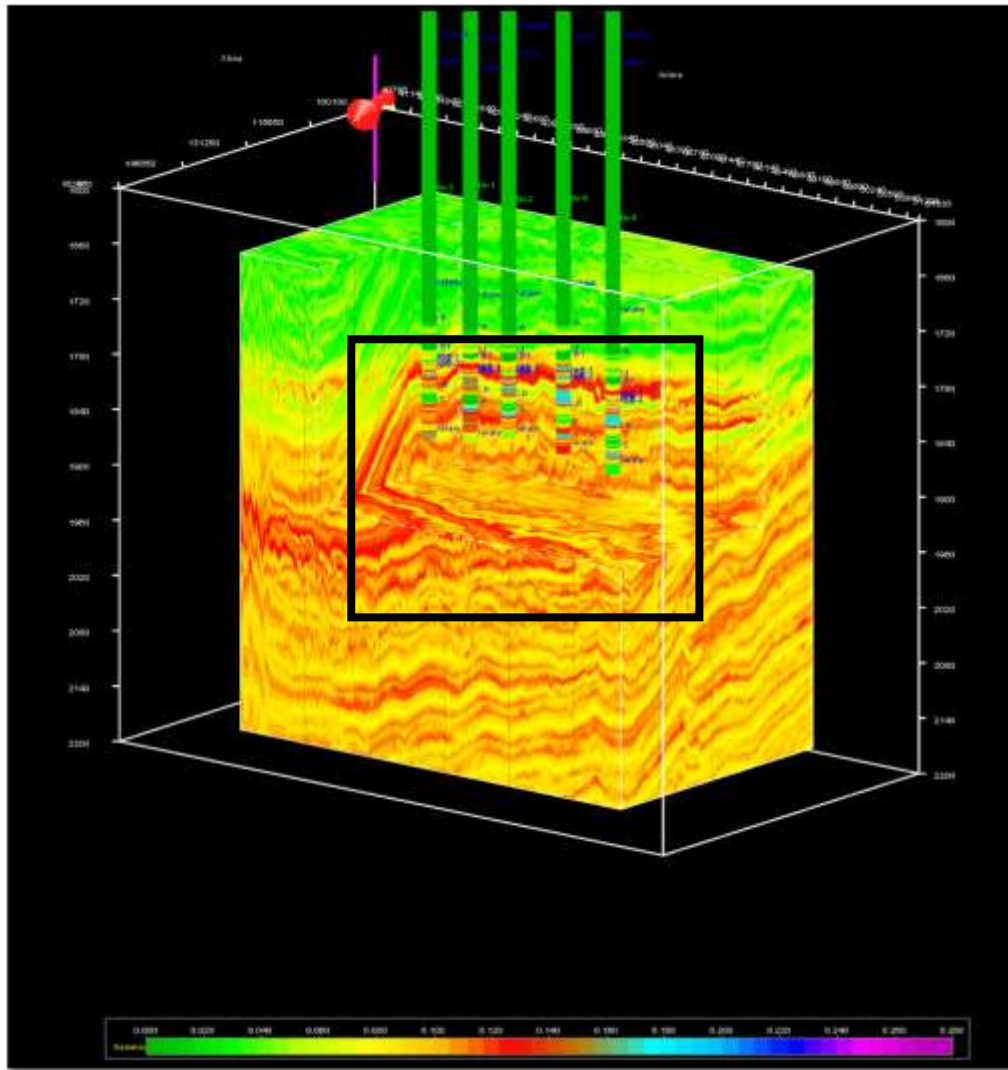
Figure 9-3D view volume effective porosity for all subsurface of study area and the black rectangle border show interval of Yamama Formation

In addation to the effective porosity property was extract by multi attribute in emerge analysis using two external attribute computed P-wave and acoustic impedance with multi internal attributes Figure -10 show cross plot of relationship between acoustic impedance and effective porosity when increase in the acoustic impedance indicated to the decrease in effective porosity.
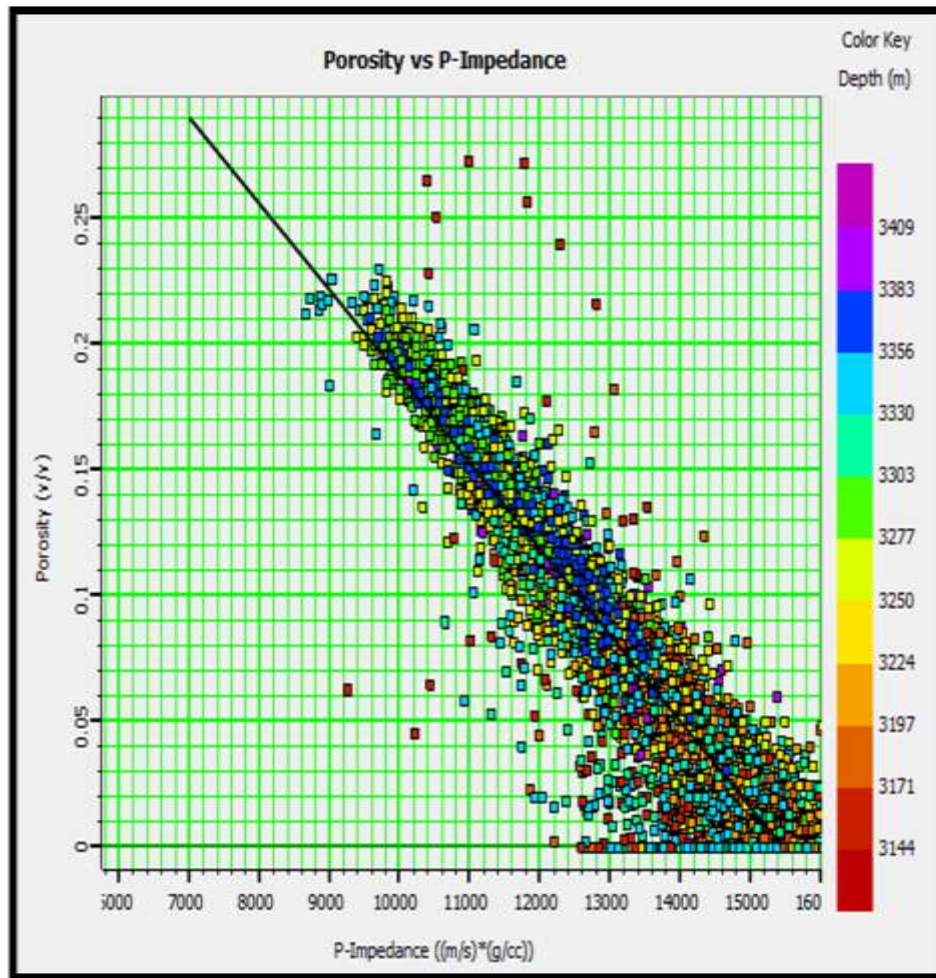
Figure 10-Shows cross plot between acoustic impedance and effective porosity.

Figure -11 shows arbitaray line shows all , the results of effective porosity volume and cutting horizon slices within reservior zones **,** the green color shows low effective porosity and indicated to the barrier between reservoir units and the red and orange color shows high effective porosity and indicated to the reservoir units**.** (Yb1,Yb3 and Yc) as shown in (Figures -12) . a: effective porosity horizon slice of unit Yb1 centered window below Yb1 horizon, shows the medium effective porosity in the crest, NW and eastern side of the anticline, indicated promised areas. b: effective porosity horizon slice of unit Yb3 centered window below Yb3 horizon, shows the high effective porosity in the crest, NW-SE and eastern side of the anticline, indicated promised areas. c: effective porosity horizon slice of unit Yc centered window below Yc horizon, shows the high to medium effective porosity in the crest and NW-SE side of the anticline, indicated promised areas.
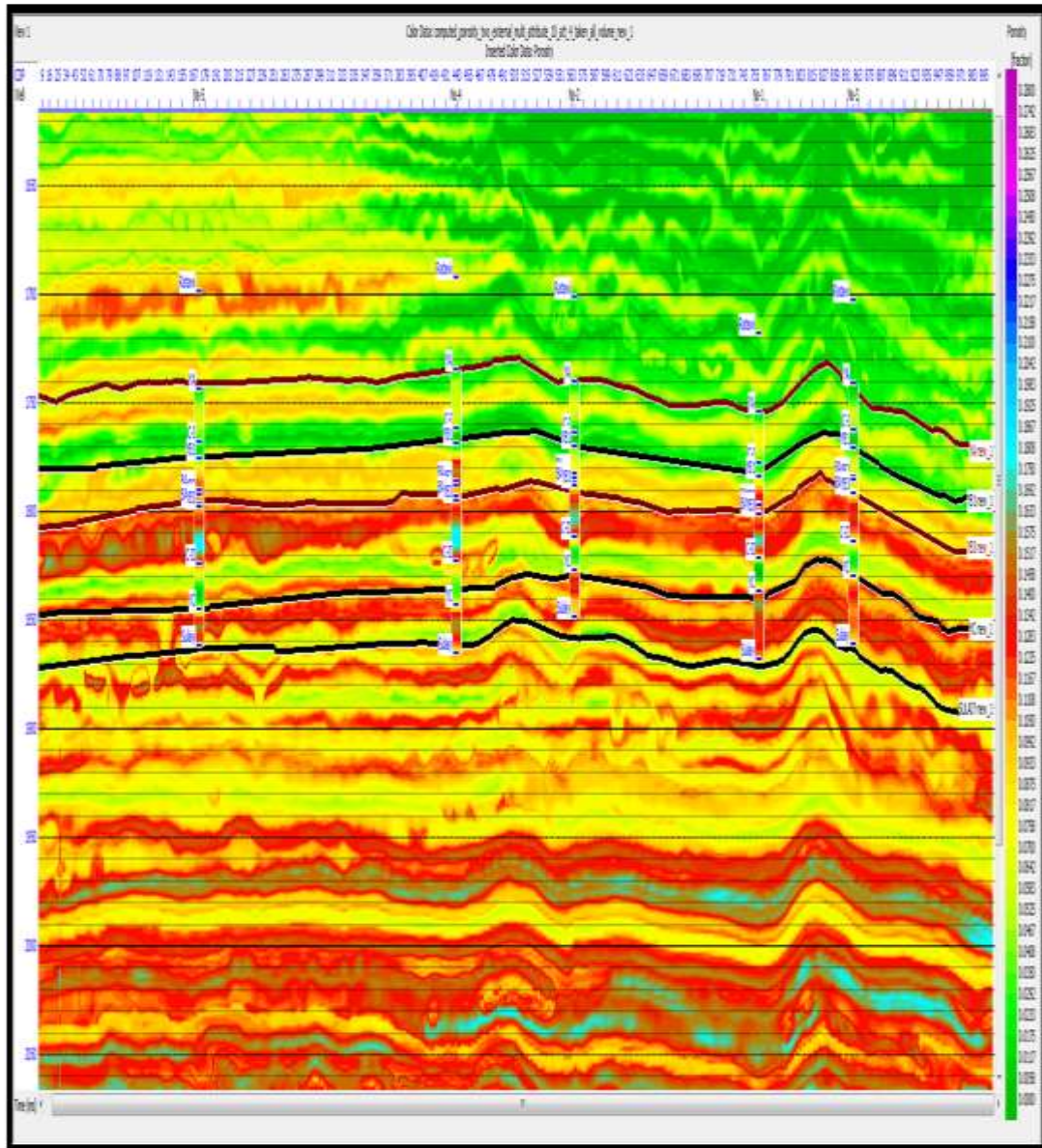
Figure 11-Arbitrary line through wells within 3D volume of predicted effective porosity.
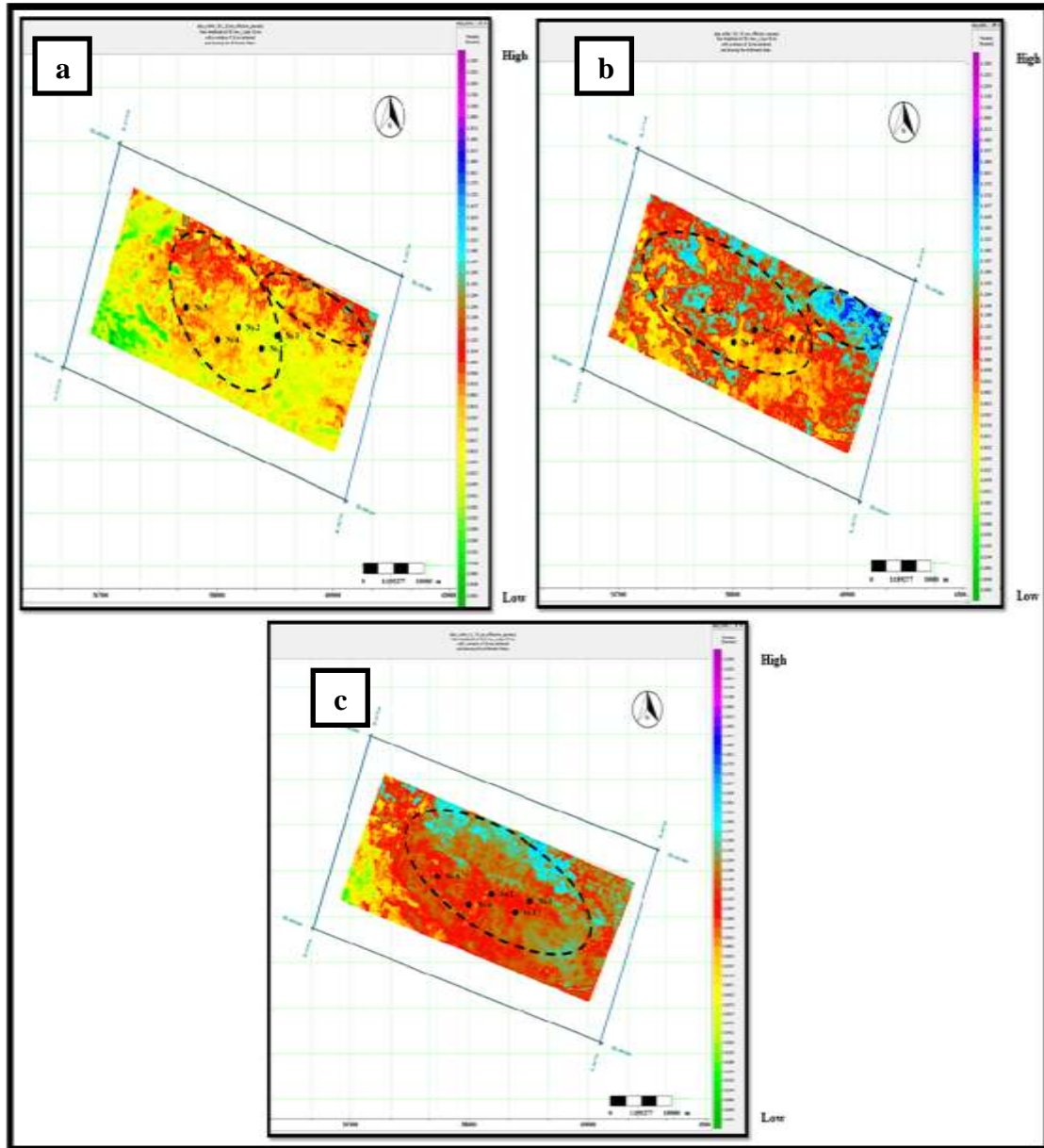
Figure -12-Effective porosity horizon slices of unit Yb1, Yb3 and Yc.

7- **Conclusions**

1- Emerge analysis (training and application) were used to estimate reservoir properties (effective porosity) with multiattribute analysis to derive relations between them at well locations.

2- The result of effective porosity horizon slices of unit (Yb1, Yb3 and Yc), appear as following:

a- Effective porosity horizon slice of unit Yb1 shows the medium effective porosity in the crest, NW and eastern side of the anticline indicated promised areas.

b- Effective porosity horizon slice of unit Yb3 shows the high effective porosity in the crest, NW-SE and eastern side of the anticline indicated promised areas.

c- Effective porosity horizon slice of unit Yc shows the high to medium effective porosity in the crest and NW-SE side of the anticline indicated promised areas.

References
1. O.E.C., **2007,** Integrated reservoir study updating of Nasriya field, Oil Exploration Company, unpublished study.
2. O.E.C., **2011,** Final processing report for Nasriya oilfield 3D seismic survey, Oil Exploration Company, unpublished study, 47 P.
3. Al-Ameri, T. K. **2010.** Petroleum systems in Iraqi oil field lectures presented in department of geology, University of Baghdad, (Extended Abstract).
4. Al-Khadimi, J. A., Sissakian, V. K., Fattah, A. S., and Deikaran, D. B. **1996.** *Tectonic map of Iraq,* (Scale: 1:1 000 000) S. E. of Geological Survey and Mining, Iraq.
5. Sadooni, F. N. **1993.** Stratigraphich Sequence, Microfacies, and petrolemprospects of Yamama formation, Lower cretaceous, Southern iraq*, AAPG*. **77**(111): 1971- 1988.
6. Al-Siddiki, A.A. **1977.** Subsurface geology of southern Iraq. 10th   Arab Petrol. Conger. Tripoli. Libya, P. 47.
7. Chatton. M., and E Hart, **1962.** Announcement of a rock unit redefined. Ratawi Formation: O.E.C unpublished report, 3P.
8. Hampson, D., Schuelke, J, and Quieren, J. **1999.** Use of multi-attribute transforms to predict log properties from seismic data: submitted to *Geophysics*.
9. Schultz, P.S., Ronen, S., Hattori, M. and Corbett, C. **1994.** *"Seismic-guided   estimation of log properties",* Parts 1 (May), 2 (June) and 3 (July), The Leading Edge, vol. 13, p. 305-310, 674-678 and 770-776.
10. Hampson, D. P., Schuelke, J.S. and Quirein, J.A. **2001.** Use of multiattribute transforms to predict log properties from seismic data, *Geophysics*, January-February, **66**(1): 220-236.
11. Draper, N.R. and Smith, H. **1966.** *"Applied regression analysis"*, John Wiley & Sons, Inc.