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INTEGRATED PETROLEUM RESERVOIR CHARACTERIZATION. THE CASE OF ZHAO57 BLOCK (Es4 + EK1)

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ABSTRACT

This paper put forward the result of a case studied from a reservoir characterization carried out on Es4+Ek1 reservoir of the Zhao57 block, Zhaozhouqiao oil field, Hebei Province, China. The objective of the study was to accurately create a reservoir model of the oil field and use it to forecast oil and gas production. To achieve this, we characterized the formation by applying integrated geologic and engineering data for the purpose of providing insight understanding of controls on oil and gas production. The formation was first divided into seven groups and fifty four small layers, followed by stratigraphic correlations and quantification of sand thickness. The fifth group was found to be the main oil bearing formation, its top mainly comprise of siltstone while the middle and the bottom comprise mainly of thick layer of massive sand. Sandstone density presents decreasing trend from northwest to south east. Structure model on the fifth group depicts a series of faulting which is believed to be a contributing factor on oil and gas distribution in the group. Average porosity on the fifth group is found to be 7.54%, average permeability is as low as 2.6mD and reserve estimation recorded a value of 82.5364x104t with the V-12 and V-13 layers showing the highest reserve. Result derived from this study will no doubt be useful in respect of further development of the field especially during secondary and tatiary recoveries.

Keywords: Reservoir, Model, Permeability, Porosity, Sand distribution

INTRODUCTION

The petroleum industry have huge requirement for investment in order to achieve reliable exploration, development, and recovery of petroleum from petroleum and/or gas reservoirs. To provide certainty for recouping investments, operate a reduced costs and mitigate the risks involved with production, investors must draw up impeccable development strategies. To achieve this, they need to have a reliable reservoir model that will clearly portray a clear image and properties of the subsurface. This is also coupled with the need to further enhance reservoir characterization and modeling.

Reservoir characterization is the process of integrating various forms of data for the purpose defining reservoir structure, facies characteristics, petrophysical properties mainly porosity and permeability for possible reserve estimation. An ultimate target of reservoir characterization is to provide an improved prediction of the future performance of the reservoir (Bahar and Kelkar, 2000). To make real that goal, a passage through various processes must come to elapse. The more rigorous the processes, the more defined the prediction will be. The most important processes in this journey are the incorporation and analysis of the initial available geological and geophysical information（Burno JP etal, 2004）. It starts with data acquisition through reservoir static and dynamic studies to development planning. Data gathering is the very beginning for every reservoir study in which variety of information is collected for evaluation. The next step is top identification and top mapping, which have to do with the geophysical interpretation of seismic data set (Christoforos and Viberti, 2010) usually inline with proper understanding of reservoirs sedimentology thus allowing the further interpretation of geological trend of the reservoir under study. This allows for definition of surface that corresponds to tops and bottoms of the reservoir layers, thus the reservoir model construction begins. Horizons and faults are continuously identified and mapped to be used at a later period during the grid construction. According to lucas cosentino, 2001, fault modeling is the most important aspect of the structural modeling because of its impact on reservoir compartmentalization which can have a direct effect on reservoir fluid flow.

Stratigraphic modeling is an important aspect due to its implication on the overall accuracy of oil field development. Progressive application on this area follows the principle of sequence stratigraphy (Octavian, 2002), an area of study that predicts the geometry of reservoir based on corresponding sea level changes and depending on sedimentation pattern. For cases that are not convenient for application of sequence stratigraphic principle, a basic well to well correlation method in terms of real depth or with respect to a reference datum level can be applied. Having obtained that, facies modeling which consist in populating the developed model with the appropriate facies distribution forms the next step. These facies are identified on the bases of data gathered from the wells using specific classification criteria and subsequently disseminated on the developed structural and stratigraphic model using some algorithms. The motive behind facies modeling is that petrophysical properties of reservoirs are closely related to the lithological facies (Xu et al., 2009), thus becoming a basis for petrophysical modeling.

Petrophysical modeling defines and characterize the quantitative aspect of the porous space in reservoir rock, an area of great importance in revoir development, because it forms the basis for reservoir fluid flow. The property of porous media is proportional to its mineralogy, texture and granulometry. This in turn are functions of the depositional environment and the post depositional activities like cementation, diagenesis, fracturing and dissolution which might have effect on the rock after formation.

Petrophysical properties such as porosity and fluid saturation are the most important parameters controlling the amount of hydrocarbon in the reservoir (Babadagli et al 2007) while permeability controls the reservoir fluid flow capacity (J.P.

Rolando, 1998). Initial values for petrophysical application are derived from core samples and well logs, while their distribution on the model is controlled by statistical or deterministic methods (Djebber and Donaldson, 2004). With this model available, static reserve estimation can be carried out using volumetric equations.

The work presented in this paper provides a methodology to model a 3D reservoir model and carry out a simulation forecast on oil production, oil rate, water production and water cut until 2021. This methodology is based on the step-by-step procedure followed and applied on the Es4+Ek1 reservoir of the Zhao57 block. It starts with top picking in the form of seismic – well logs calibration followed by stratigraphic analyses to the sandstone density quantification, thus forming a base for petrophysical evaluation. Reservoir properties were distributed based on a developed 3D model of the area and reserve estimation was conducted, hence putting on the table a better understanding of the area. Fluid models, saturation functions and rock compaction functions were also added to the model. A development case to define how the simulation will be carried out was added as well. The simulation case was then created by putting all the above data objects together. The simulation case was then exported from Petrel software and the simulation process carried out in Eclipse software. The main target was the simulation of the indexes water cut, oil rate, oil production and water production.

Field Exploration and development conditions

Zhao 57 block is located in Zhaozhouqiao oil field, Zhao County, Hebei province, China. The block has experienced 20 years of exploration and development, which can be roughly divided into the following four stages:

i. The first phase (March 1977- January 1993), Concentrated mainly on southern part of the depression in south central Jin County in which the Zhao lanzhuang high H2S-containing hydrocarbon reservoirs discovery took place.
ii. Second phase (January 1993 - December 1995), followed with a discovery of non-H2S oil and gas reservoirs at the main depression of central and southern Jin County, which is now the Zhaozhou bridge oilfield.
iii. Third phase (January 1996 - 1997), exploration continued through the main depression to the central and southern non-H2S hydrocarbon reservoirs and a breakthrough was recorded with the discovery of the Zhao57 block (Es4 + EK1) non-H2S oil and gas reservoirs (Figure 1)
iv. The fourth phase (January 1998 - present), makes full use of new technology in the implementation of modern exploration and development activities such as Seismic data processing, lateral reservoir prediction using new technologies and methods.

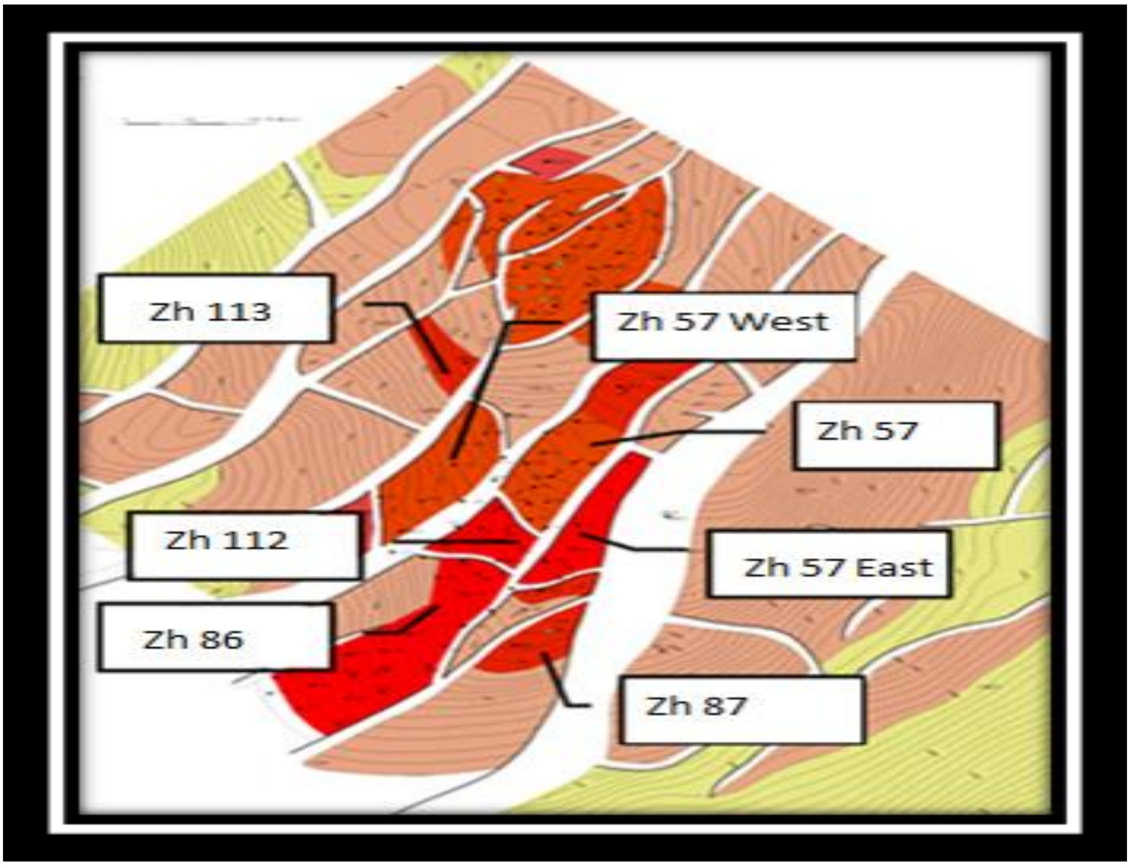

Figure 1: Zhao 57 Block Secondary Fault Block Map

Zhao 57 block has proven oil-bearing area of 6.2km2, proven geological oil reserves of 605 × 104t and a total 78 wells in which there are 9 cored wells as follows: Zhao 57, Zhao 80, Zhao 82, Zhao 86, Zhao 112, Zhao 113, Zhao 110, Zhao 103X1, Zhao 87, with coring total footage of 196.6m as shown in table 1. There are fifteen samples of pressure mercury items derived from four wells in which 2 wells have thirty-one samples of clay mineral X-ray diffraction analysis and three wells with oil-water relative permeability data. PVT data were derived from sampling wells (Zhao 57, Zhao86, Zhao 80, Zhao 110, Zhao112, Zhao 103x, Zhao 113, Zhao 57-40, Zhao 87) for PVT analysis, and dynamic data as of

October 2011 are derived from thirty-six production profile wells. Fourteen different structure maps derived from seismic interpretation of the group five reservoir, Well tops data from forty nine (49) wells together with their corresponding well logs comprising of well locations, Resistivity logs, Gamma ray logs, Sonic logs, Spontaneous potential logs and permeability logs were all available.

The Zhao57 block was in September 1997 put into trial mining, which went through three stages of development as follows;

i. September 1997 to November 1998, was in a single well test mining stage;
ii. December 1998 to May 2000, in the flexibility test to drive the mining stage;
iii. June 2000 to present time, in artificial recharge driven development phase.

Table 1: Basic Coring Data Table

Well name	Horizon		Coring times	Well section	Core length
	Layer group	Oil group		(m)	(m)
Zhao 112	Es4-Ek1	I~IV	4	2260.3-2434.7	21.5
Zhao 113	Es4-Ek1	V~V	6	2005.43-2370.2	22.04
Zhao 57	Es_{2+3}		3	1953.45-2066.43	14.65
	Es4-Ek1	II、IV	4	2129.4-2255.53	22.57
Zhao 80	Es4-Ek1	IV~VII	5	2320.38-2627.90	29.65
	Es_{2+3}	I	1	1632.74-1641.14	8.2
Zhao 110	Es4-Ek1	I~II	5	1715.0-1957.67	18.21
Zhao 103X1	Es4-Ek1	II~IV	3		
Zhao 87	Es4-Ek1	I	2	2411.20-2425.74	14.36
Zhao 86	Es4-Ek1	II、IV~VII	8	2653.52-3073.11	28.55
Zhao 82	Es4-Ek1		1	2478-2483.5	8
Total			42		406

METHODOLOGY

The general objective followed in this study was to develop an improved simulation model of (Zhao57 Block) using sequence stratigraphic concepts, geophysics, reservoir characterization, volumetric resources, and reservoir engineering concepts. The main target was the realization of more potential reservoirs and a forecast of hydrocarbon production for the next year. In order to achieve the objectives of this research, the following methodology was followed:

i. Gathering, organizing and validating data.
ii. Performing stratigraphic correlation based on the genetic unit definitions.
iii. Defining the depositional models and detailed mapping of each correlated interval of interest, according to sequence stratigraphic analyses.
iv. Integrating the structural, geophysical and geological data in order to get a coherent structural interpretation.
v. Formulating the petrophysical models and reserves estimation

Data Integration and Interpretation

Synthetic Seismogram

The seismic - well database was interpreted and validated and it allowed for the generation of synthetic seismograms used for seismic-well logs calibration. It also allowed us to analyze the cross relations between seismic attributes and petrophysical parameters, as well as the elaboration of all the structural maps. The application of all data for seismic-well calibration was the elementary approach to obtain optimum results in the depth conversions of structural maps in time, by applying the velocity law through the synthetic seismograms process (Figure 2).

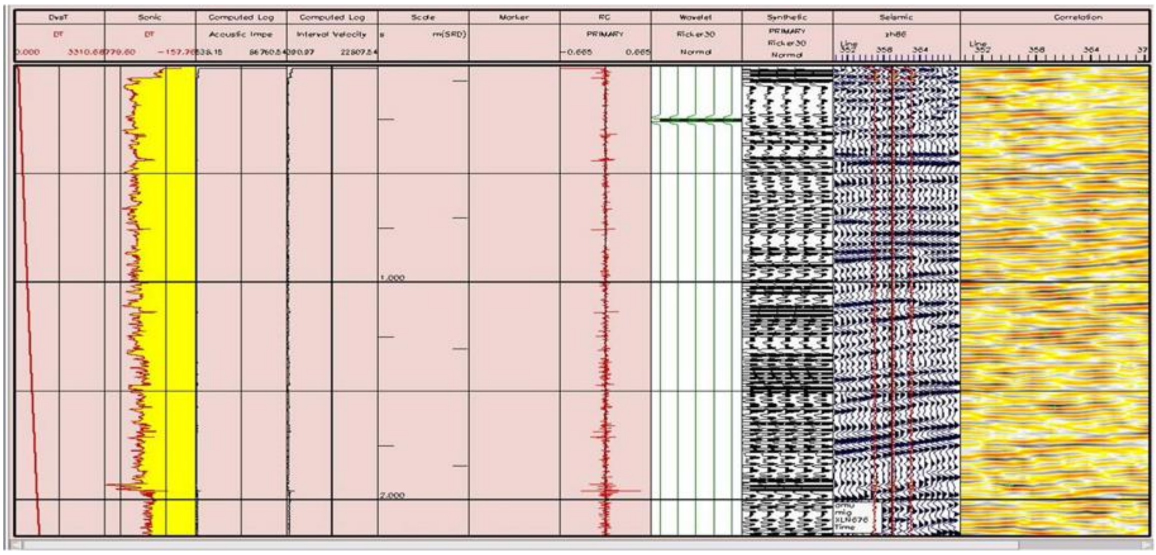

Figure 2: Synthetic Seismogram For Well Zh86 Showing The Time-Depth Scale

A good tie was observed between well bores and seismic. Despite the inability of the seismic attribute analysis to reliably detect the distribution of reservoir quality, significant conversion errors of time/depth were within seismic resolution. Also, data related to cores, well logs, and existing studies of the area were incorporated.

Stratigraphic analyses

The initial 3–D-seismic synthetic's interpretation (Figure 3), allowed a view of the stratigraphy and channel direction by the generation of seismic lines that cut through wells of interest. This allowed for the resolve of thickness variability or continuity between the seismic reflectors and the kind or magnitude of structural influence in well correlations.

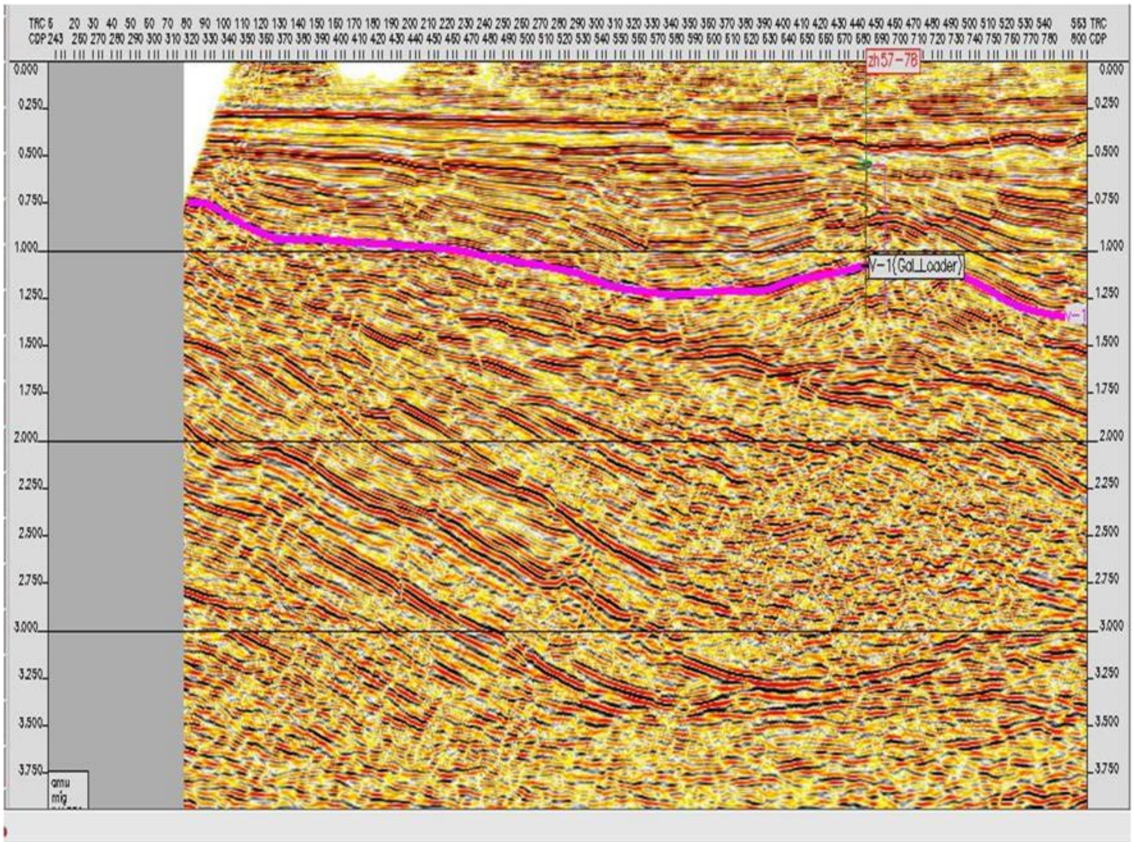

Figure 3: Preliminary 3–D-Seismic Synthetics Interpretation

Results from geological interpretation were represented in the individual composite logs of each well, and were reorganized in stratigraphic sections. According to the principle of the small layer subdivision, small layers of Es4+Ek1 reservoir were divided into seven groups and fifty four small layers, in which the fifth group has fourteen small layers as shown in table 2. Zhao86 was selected as the reference well for this work, which provided the initial log response data for this study, and can further be used for well to well correlation.

Table 2: Es4+Ek1 - Fine Stratigraphic Contrast Result Table

Oil group	Small layers,	number of small layer
I	1、2、3、4	4
II	1、2、3、4、5、6、7	7
III	1、2、3、4、5、6	6
IV	1、2、3、4、5、6	6
V	1、2、3、4、5、6、7、8、9、10、11、12、13、14	14
VI	1、2、3、4、5、6、7	7
VII	1、2、3、4、5、6、7、8、9、10	10
In total		54

In order to establish a clear picture of the stratigraphy of the Es4+Ek1 reservoir, based on the chosen reference well (zh86), profiles comprising twelve longitudinal and nine Transverse well sections were introduced so as to have a spread. The result is shown in figure 4, 5 & 6 and table 3, covering nine sections of the formation, thereby reflecting the overall trend. More correlations were carried out to further investigate its stratigraphy, (Figure 7 and Figure 8) which further reveal that the current direction is from northeast to southwest trending. Meanwhile based on the vertical electrical properties and horizontal comparisons, five significant characteristics where observed as shown in table 4.

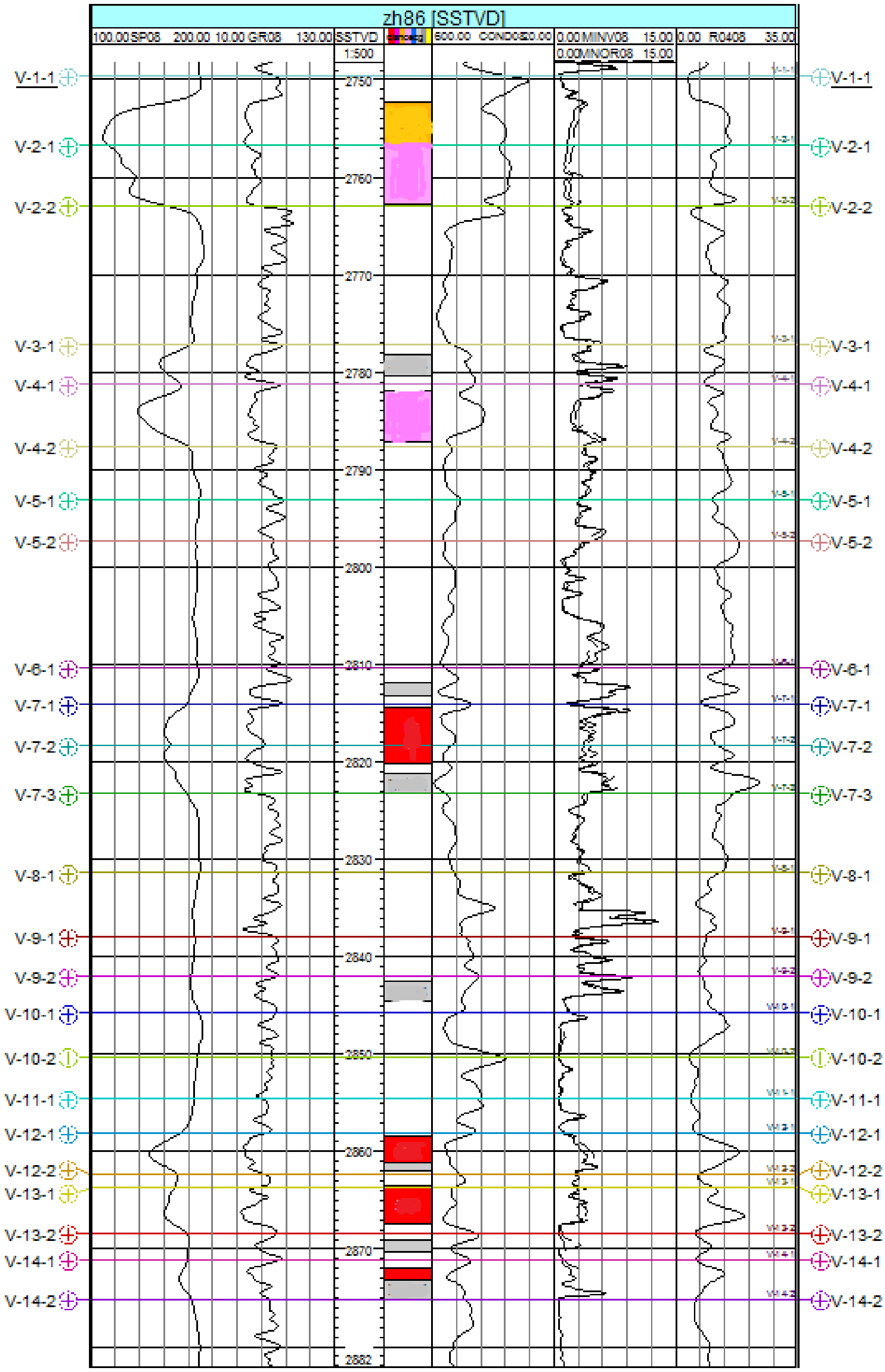

Figure 4: The Reference Well Zh86, Showing the Stratigraphic Sections of the V Oil Group

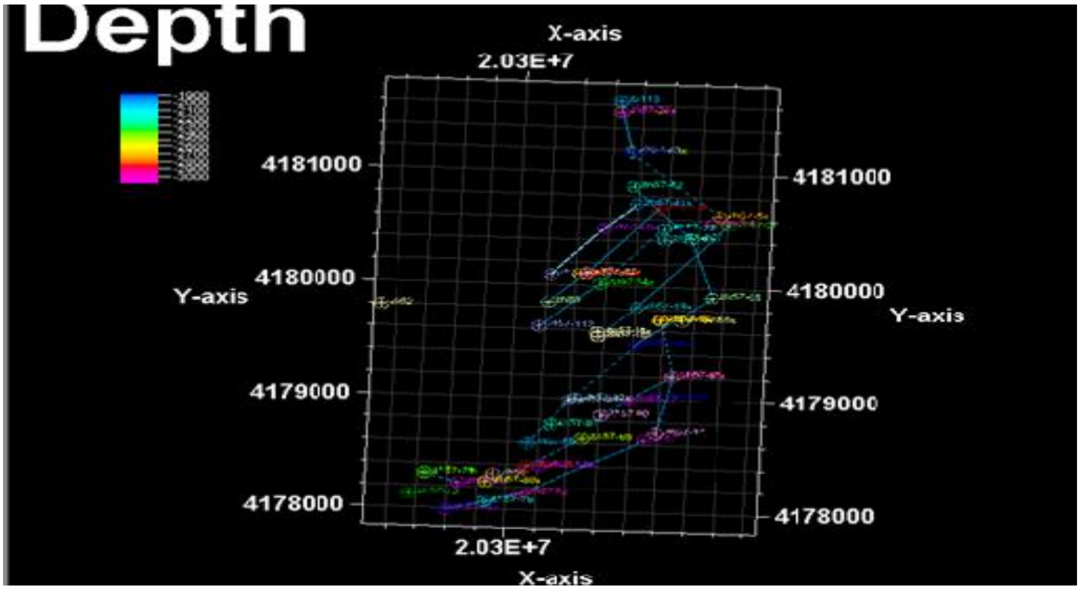

Figure 5: Skeleton Section Network Diagram

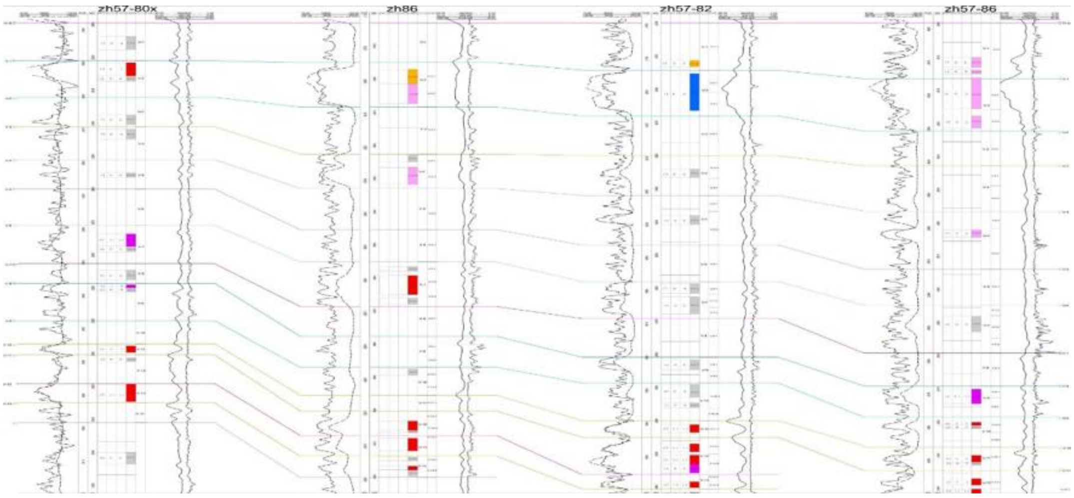

Figure 6: A Stratigraphic Section of the Es4+Ek1 Reservoir (North – South Trending)

Table 3: Small Layers Contrast Section Well Lines

Zhao86	Transverse section	Section1	Zh57-93—zh57-85—zh57-81—zh57-83—zh57-89
		Section2	zh57-80x—zh86—zh57-82—zh57-86
		Section3	zh57-79x—zh57-76—zh57-78—zh57-71
		Section4	zh57-74—zh57-75—zh57-77x—zh57-70x
		Section5	zh57-92x—zh57-91—zh57-90
	longitudinal section	Section6	zh57-91—zh57-93
		Section7	zh57-90—zh57-87—zh57-85—zh57-80x—zh57-79x—zh57-74
		Section8	zh57-88—zh57-81—zh86—zh57-76—zh57-73
		Section9	zh57-84x—zh57-83—zh57-82—zh57-78—zh57-75
		Section10	zh57-89—zh57-86—zh57-71—zh57-77x—zh57-72

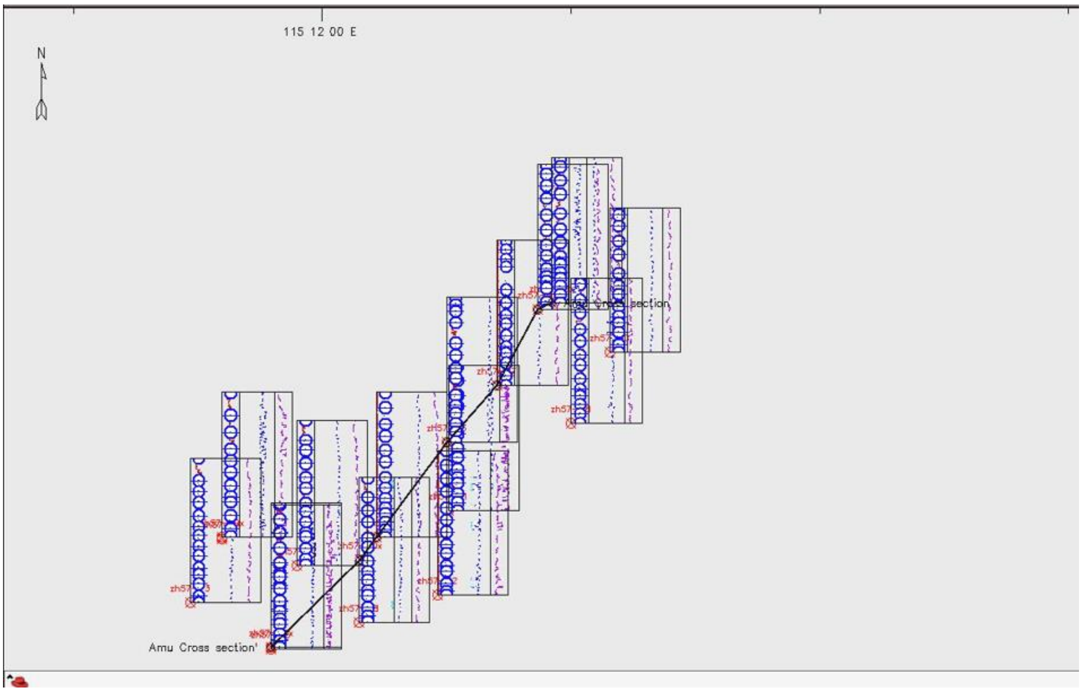

Figure 7: A Cross Section Of Group V (North East – South West Trending)

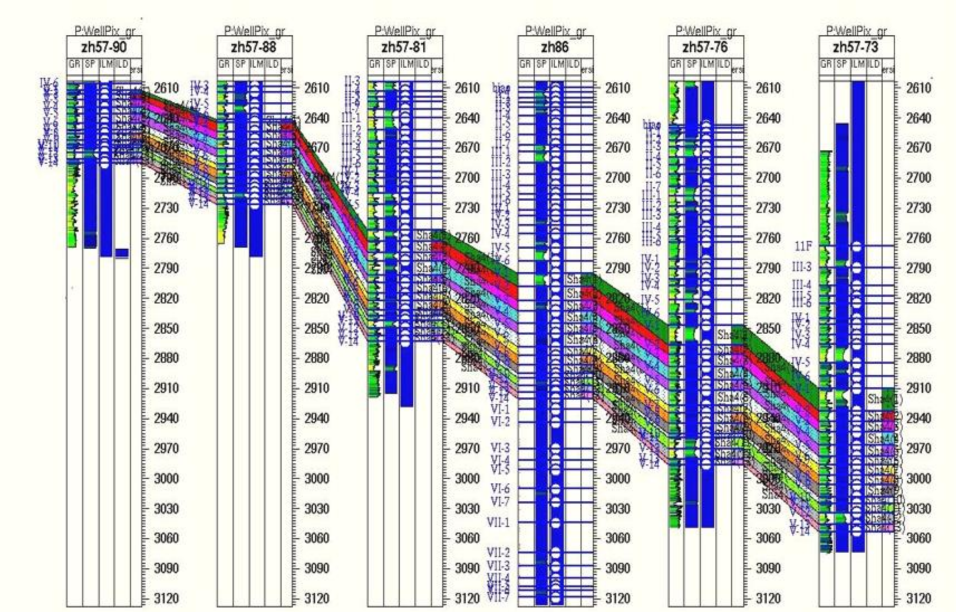

Figure 8: Showing the Group V Correlation and Channel Direction

Table 4: Es4+Ek1 Reservoir Average Sandstone Density

Small layers	The average density of sandstone (%)	Small Layer	The average density of sandstone (%)	Small layers	The average density of sandstone (%)
I2	0	III3	27	V3	9
I3	29	III4	21	V4	18
I4	18	III5	18	V5	10
II1	15	III6	12	V6	10
II2	47	IV1	15	V7	30
II3	60	IV2	26	V8	12
II4	67	IV3	28	V9	33
II5	10	IV4	13	V10	17
II6	17	IV5	60	V11	33
II7	34	IV6	69	V12	56
III1	72	V1	18	V13	68
III2	65	V2	51	V14	23

Determination of sand thickness and depositional tendencies

Quantification of gross and net sand thicknesses together with depositional tendency maps were performed from well logs in respect of the entire formation. Figure 9 to 13 shows the sandstone thickness maps for the group I to group V reservoirs, in which we observed that the nearer to the source of sandstone, the greater the sedimentary microfacies usually from northwest to the south east. They were paleodelta plain distributary channel sand body, front water sand body, estuary dam sand body, sheet plain sand body and beach bar sand body were observed. It can be seen also from the figure that the sandstone density from northwest to Southeast present decreasing trend. Average sandstone density for each layer of the Es4+Ek1 formation is presented in table 5.

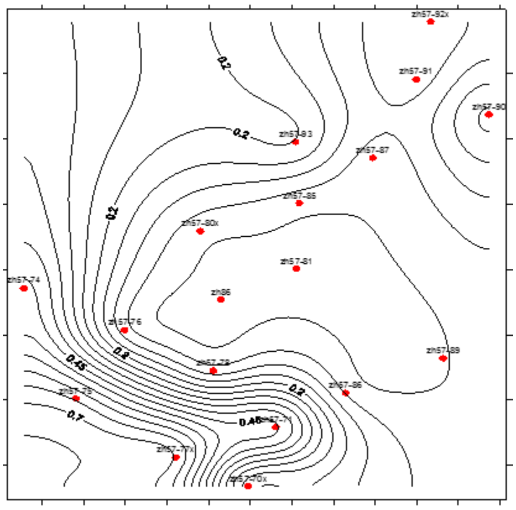

Figure 9: First Oil Group (I) Sandstone Density Contour Map

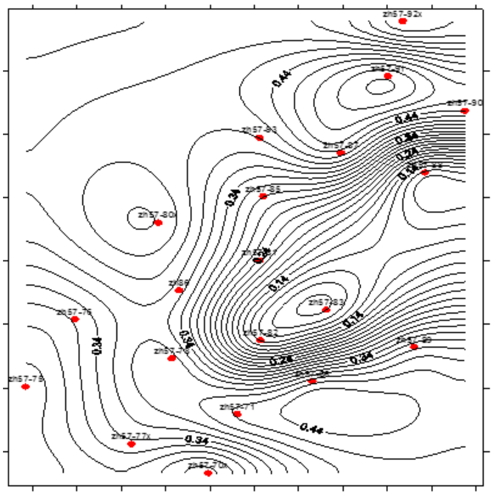

Figure 10: Second (II) oil group Sandstone Density Contour Map

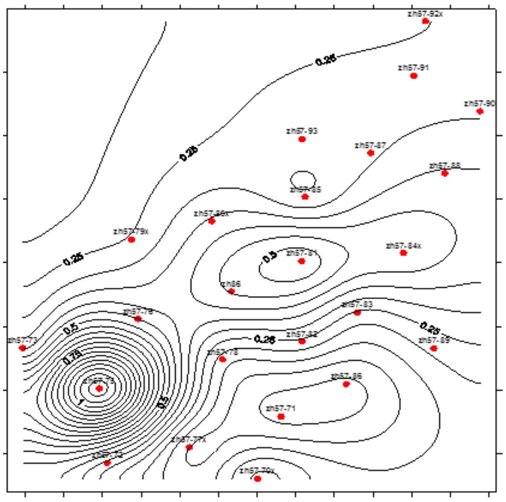

Figure 11: Third (III) Oil Group Sandstone Density Contour Map

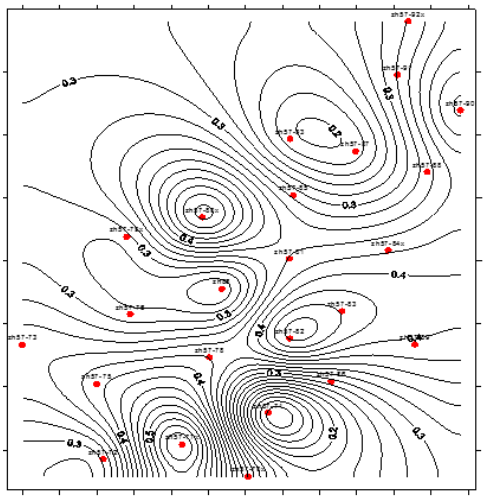

Figure 12: Fourth (IV) Oil Group Sandstone Density Contour Map

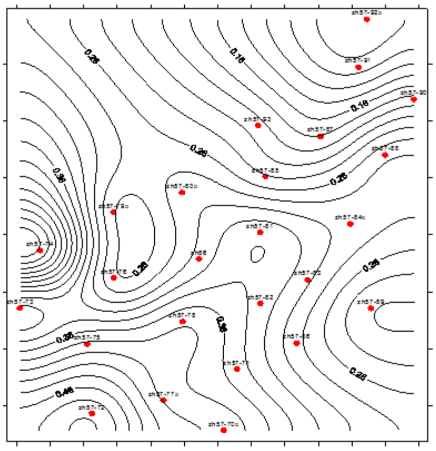

Figure 13: Fifth (V) Oil Group Sandstone Density Contour Map

Table 5: The Formation Stratigraphic Characteristics

Time				thickness	lithology	electrical property	Oil-bearing property
group	**system**	**formation**	**zone**	**m**			
Cainozoic group	Quaternary	Pingyuan formation		240 | 290	Un-digenetic gravel layer and clay	The resistivity curves present peaks with middle and high values concentration. The SP curves present tongue-shape with negative anomaly of low amplitude.	
	Neogene	Minghuazhen formations		270 | 320	Variable thickness-inter-bed of thick massive sand and brown-red or light yellow mud.	The resistivity curves present interactions of sparse peaks with middle and high values and serration with low values. The SP curves present a little gentle with partial anomaly of low amplitude.	
		Guantao formation		810 | 860	Variable thickness-inter-bed of light yellow/gray, Yellow massive pebbly sandstone and brown-red mud.	The resistivity curves present sharp-knife shapes with middle and high values or peaks with middle values. The SP curves have lesser abnormal amplitude.	
	Palaeogene	Dongyin formation		320 | 360	Variable thickness-inter-bed of lightbrown/lightgray thick layer silt sandstone and mud.	Most resistivity curves present sharp-knife shapes with high values or peaks with middle values. The SP curves have lesser abnormal amplitude.	
		Shahejie formation | Kongdian formation	Sha 1 member	200 | 300	Variable thickness-inter-bed of fuchsia mud and light/brown/lightgray siltstone,intercalating marlstone.	The resistivity curves present peaks with middle values and serration with low values. The Anomaly amplitudes of SP curves are not large.	
			Sha 2、3 member	560 | 1000	Nearly equal thickness-inter-bed of brown, light brown, gray, lightgray, sand and mud.	The resistivity curves present serration with low values moundy. The SP curves present negative anomaly of high amplitude.	Partial oil-bearing section
			Sha 4 member | Kong 1 member	640 | 810	The lithology of the top is fine, it is dark grey marlstone with thin-thick layer silty sandstone or pebbly sandstone. The lithology of the middle part and the bottom are variable thickness-inter-bed of dark grey/grey salt lime creaming 、 gypsum –bearing mudstone and thick-layer massive sand.	At the top， the resistivity curves present small Sharp knives shapes or serration, the amplitude of SP is middle. At the middle part and the bottom, the resistivity curves present sharp-knife shapes with high values. The SP curves present fingerlike negative anomaly.	The main oil-bearing section

Structural Maps

Though, the in-depth structural map resulted from seismic interpretation according to the defined velocity model; we also contributed to the elaboration of structural maps by checking the in-depth fault dipping, structural shifts over faults, location of wells and structural contour. Several iterations were done until reaching satisfactory results for each of the interpreted seismic markers. Figure 14 shows the structural map of V-12 oil group.

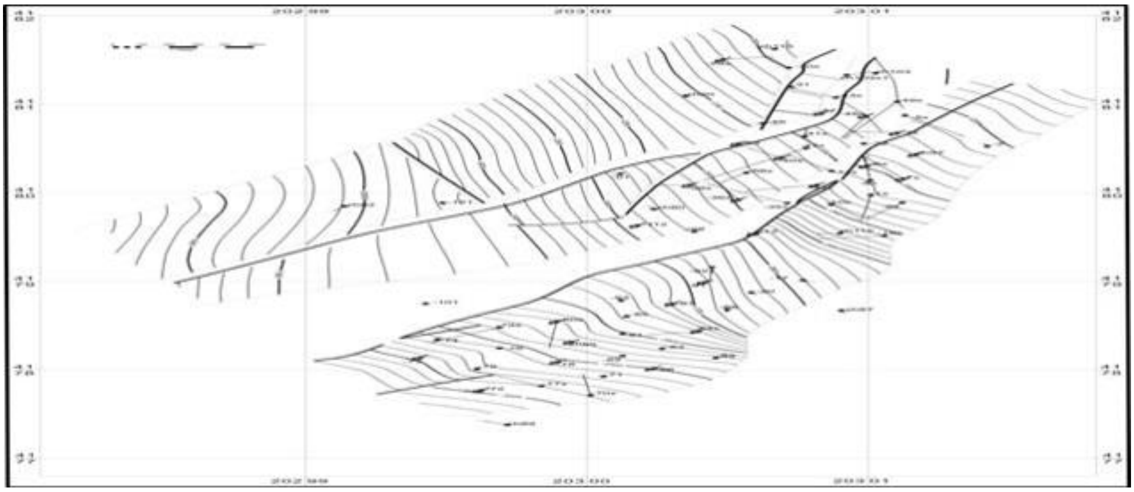

Figure 14: Structure Map of V-12 Oil Group

RESULT

Zhao57 reservoir 3D static modeling (v oil group)

In the process of further characterizing the Es4+Ek1 reservoir we narrow down our focus on group V (Sha4 member) by developing a 3D structural and property model of the group in which our target was to further identify more profitable layers in the group.

Structural Model

The group V formation presents some NE and NW trending faults. Originating from Northeast is a series of long strip fault block traps. The formation developed two sets of normal faults, in which fault size, can be divided into four levels. Almost parallel to the four NE-trending faults, four step-broken order faults further complicated the internal faulting, this structural pattern distribution plays varying degrees of controls to the distribution of oil and gas within the formation. A 3-Dimensional representation of the fault is presented in figure 9, fourteen structural markers were as well modeled there by making the formation subdivided into thirteen different zones. A 2-Dimensional representation of the structural marker and the entire structure is shown in figure 16 and figure 17 respectively.

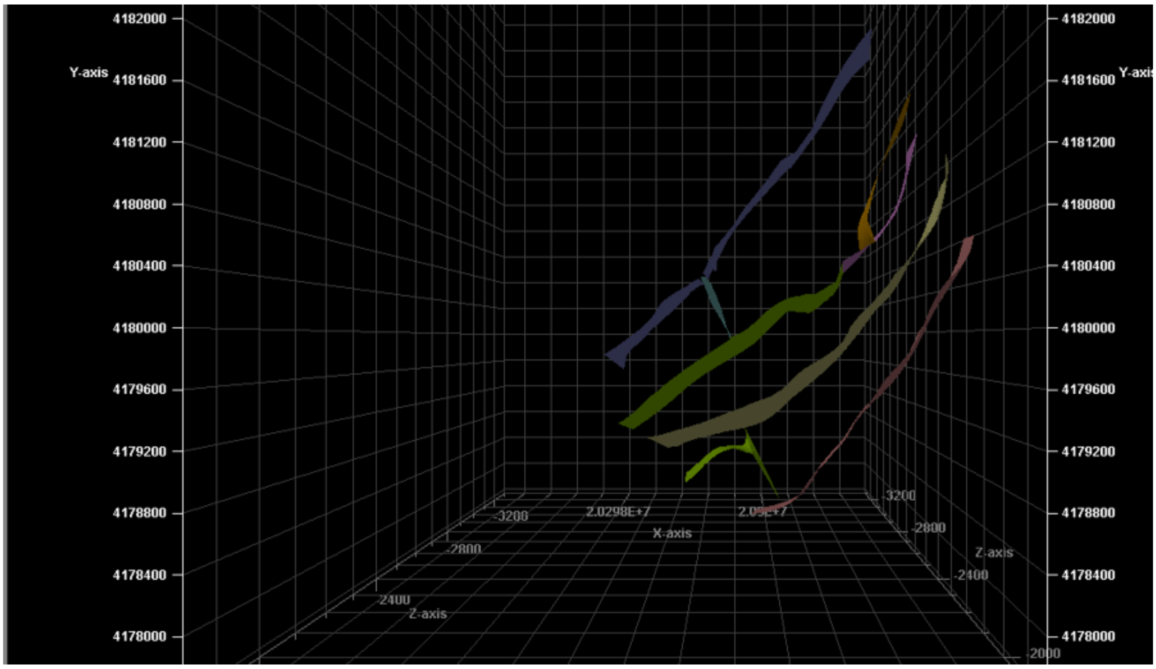

Figure 15: Group V, Fault Network

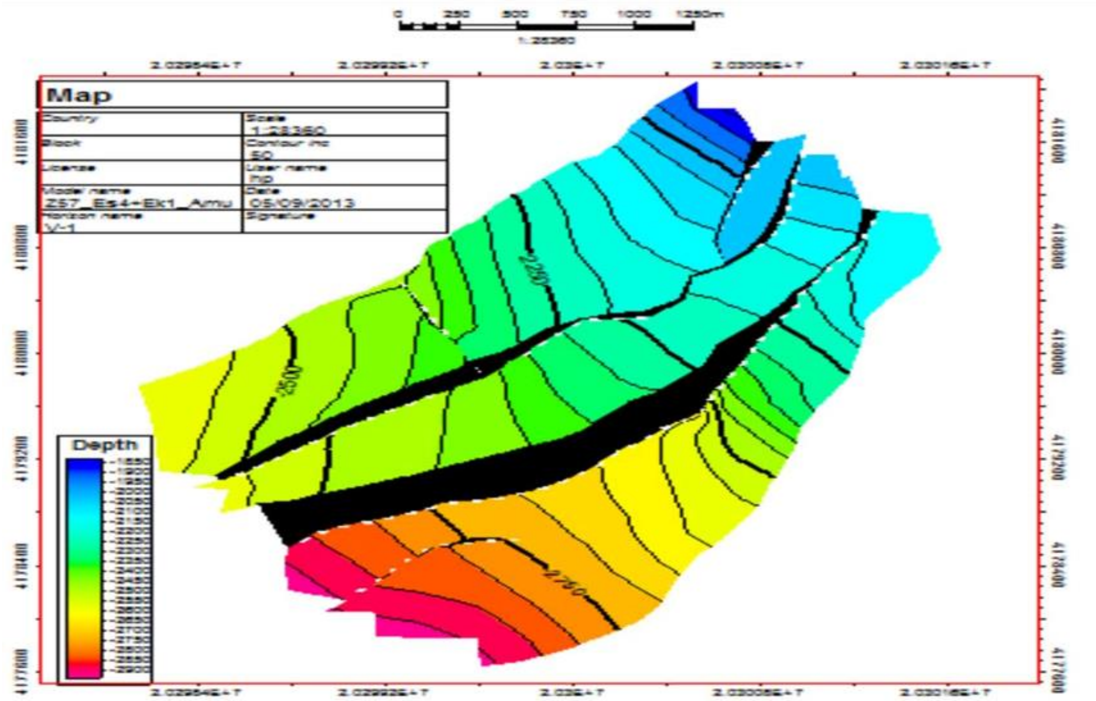

Figure 16: V -1 Marker Representing the Top Of Group V

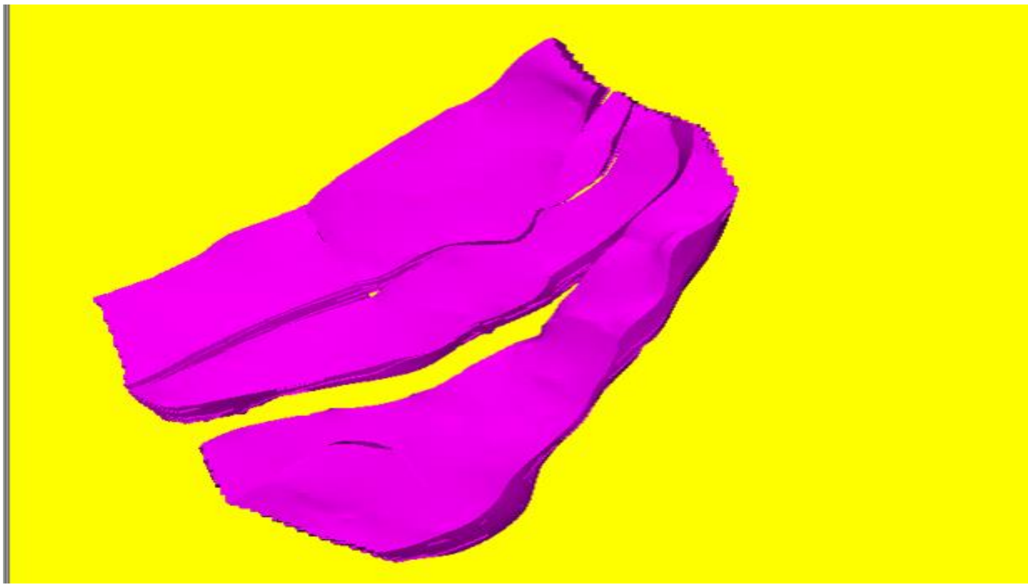

Figure 17: Group V, Two-Dimensional Structure Model

Property model

Reservoir attributes were built based on the structural model, on the basis of the developed three- Dimensional structure. Reservoir properties were populated at the inter-well locations by applying the sequential Gaussian Simulation coupled with collected co-krigging and the 3 Dimensional property grids were established.

Formation porosity distribution for the V oil group is shown in figure 18. Statistics show that porosity is mainly distributed between 3.8 ~ 11.1%, with an average of 7.535 %. Formation porosity histogram is shown in figure 19.

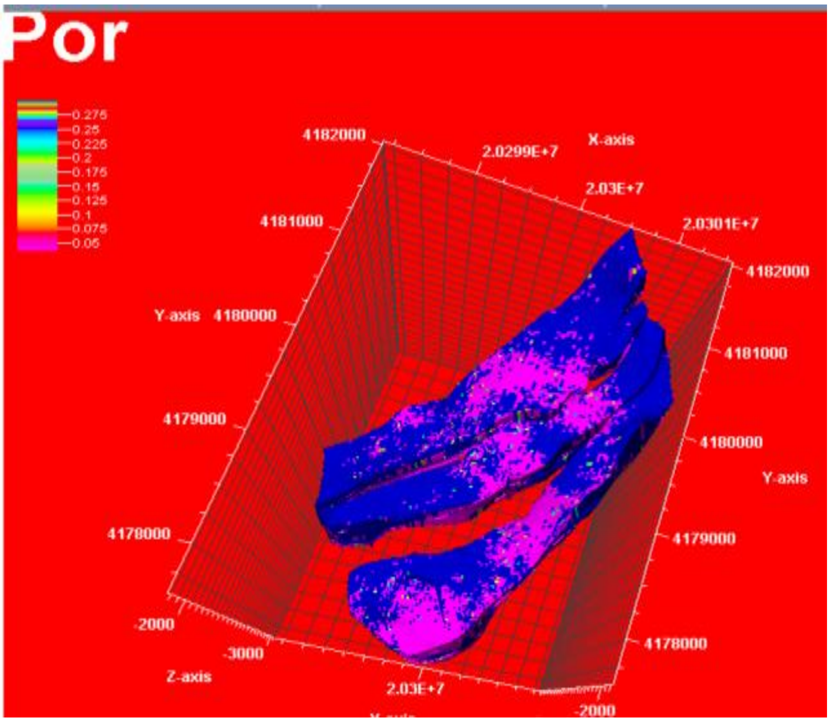

Figure 18: Group V Formation Porosity Distribution

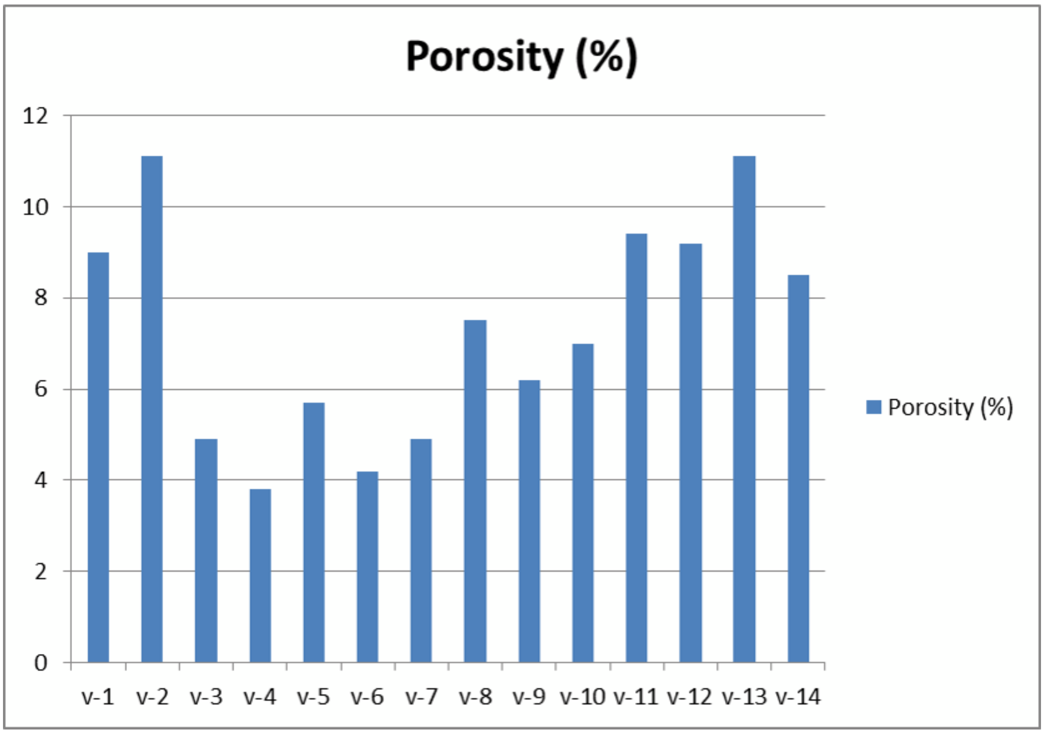

Figure 19: Group V Formation Porosity Histogram

Formation permeability for the V oil group is shown in figure 20. Statistics show that each layer of the V oil group have permeability mainly distributed between 1.0 ~ 6.1 md, and an average of 2.36md. Layers present similar average permeability, but at maximum points, the values of the inner layers have a larger differential. Formation permeability histogram is shown in figure 21.

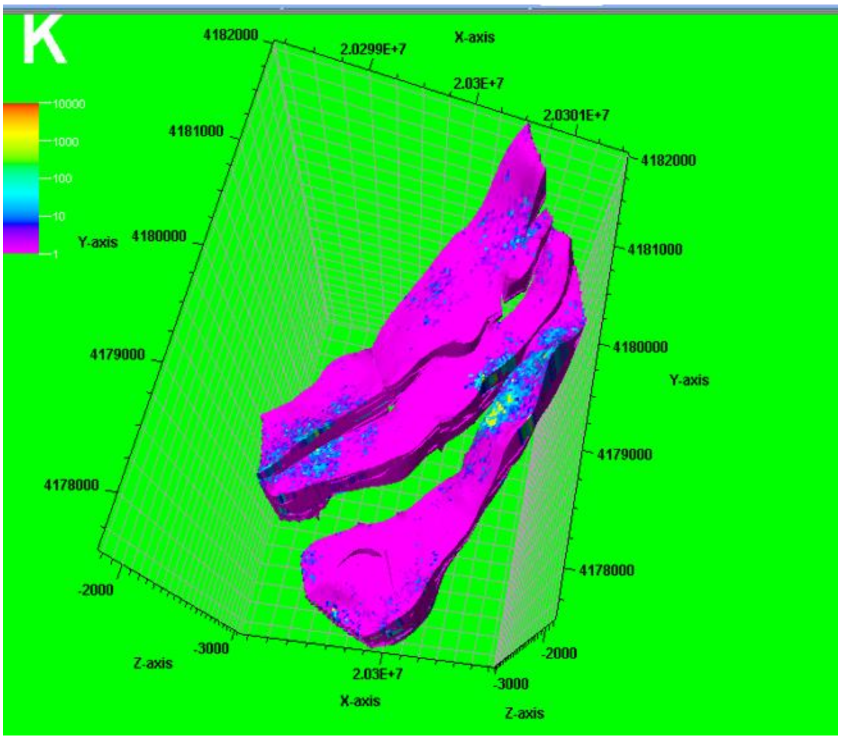

Figure 20: Group V Formation Permeability Distribution

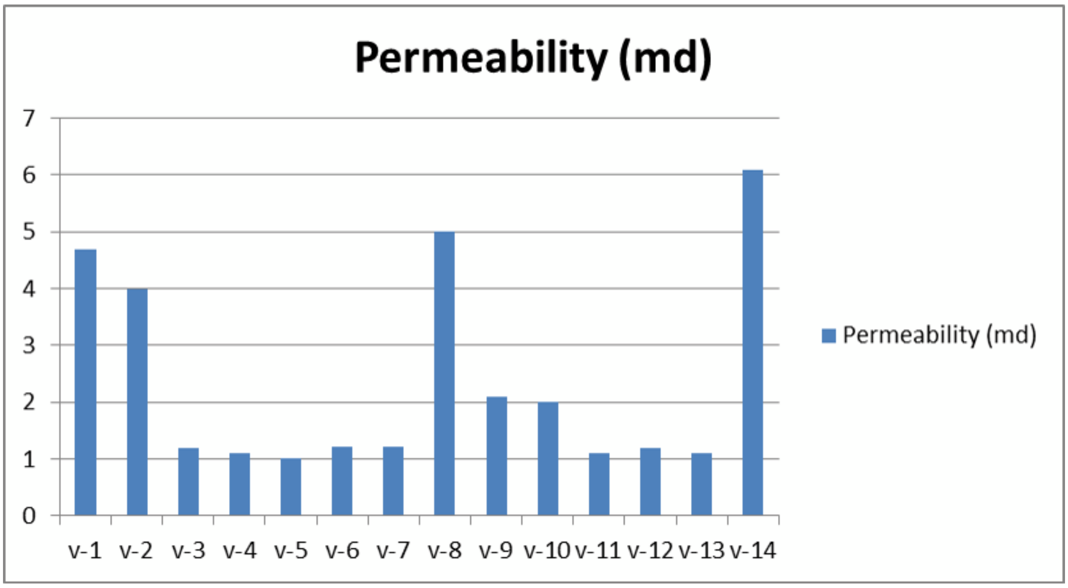

Figure 21: Group V Formation Permeability Histogram

Reserve Estimation

Based on the porosity distribution obtained for each layer together with the available dynamic and static data provided, the estimation of hydrocarbon originally in place was carried out according to the following equation:

N=100AhΦ(1-Swi)ρ0/Bio

Where; N —Oil in place 104 m3, ρ0 – Average ground crude oil density (t/m3), A — Average oil bearing area (km2), h — Average effective thickness (m), Φ— Average porosity (%) , Swi— Initial water saturation, Boi — Oil volume factor.

The result is shown in table 6, with the V-12 and V-13 reservoirs showing highest value of hydrocarbon in place.

Table 6: Reserve Estimation Result

	Layer	Oil bearing Area (km^2) A	Effective average porosity (%) Φ	Effective thickness (m) h	Initial Water saturation (%) So	Average ground crude oil density (t/m^3) ρ	Oil Volume factor Bio	Oil in Place (10^4t) N
V	V-1	0.23	9.0	3.0	62.0	0.871	1.307	2.6045
	V-2	0.37	11.1	4.6	62.0	0.871	1.307	7.7606
	V-3	0.03	4.9	1.2	62.0	0.871	1.307	0.0757
	V-4	0.20	3.8	2.6	62.0	0.871	1.307	0.8016
	V-5	0.36	5.7	2.3	62.0	0.871	1.307	1.9201
	V-6	0.05	4.2	2.4	62.0	0.871	1.307	0.1995
	V-7	0.56	4.9	2.5	62.0	0.871	1.307	2.8910
	V-8	0.20	7.5	2.5	62.0	0.871	1.307	1.5576
	V-9	1.04	6.2	1.7	62.0	0.871	1.307	4.4771
	V-10	0.55	7.0	2.1	62.0	0.871	1.307	3.2926
	V-11	0.85	9.4	1.6	62.0	0.871	1.307	5.2179
	V-12	1.26	11.2	4.9	62.0	0.871	1.307	23.246
	V-13	1.24	11.1	4.3	62.0	0.871	1.307	24.482
	V-14	0.29	8.5	4.3	62.0	0.871	1.307	4.4873

Having obtained the values for oil in place for each layer of the V oil group, we went ahead to establish a tabulated result of the available key parameters to be considered in finalizing net pay (Table 7).

Table 7: Key Parameters Influencing Net Pay

Layer	Average Sandstone Density (%)	Porosity (%)	Permeability (md)	Estimated Reserve (104t)
V1	18	9	4.7	2.6045
V2	51	11.1	4	7.7606
V3	9	4.9	1.2	0.0757
V4	18	3.8	1.1	0.8016
V5	10	5.7	1	1.9201
V6	10	4.2	1.2	0.1995
V7	12	4.9	1.2	2.891
V8	12	7.5	5	1.5576
V9	33	6.2	2.1	4
V10	17	7	2	3.2926
V11	33	9.4	1.1	5.2179
V12	56	9.2	1.2	23.246
V13	68	11.1	1.1	24.482
V14	23	8.5	6.1	4.4873

The knowledge of net pay is important in the volumetric estimation of hydrocarbon resource, a practice that underpins the value of the petroleum industry. Yet, there is no universal application of net pay, there is no general acceptance of its role, there is no accepted method for evaluating it and yet there are continuous desperate views on how to make use of it.

DISCUSSION

Petroleum Reservoir Net pay

Historically, researchers apply the use of identified anomalous zones by comparing the high and low readings indications on different well log data at certain depth intervals, then apply the obtained results of these comparisons as a tool for classifying the gross interval into net pay and non-net pay intervals. In 1971, Synder applied the both gamma and resistivity logs for determination of netpay while Flower 1983 used sonic-shear-wave and resistivity logs in order to determine netpay. In another work by Cooke-Yarborqugh, P. 1984, formation pressure tester was introduced as a quick-look indicator for net pay zones. In 1998; Deakin and Manan conducted a research on detection of low contrast pays in a gas reservoir by the use of petrophysical relations on an integrated dataset.

There is a yet another comprehensive research on low resistivity pay zones by Worthington 2000, in which the author's classified low-resistivity pays into six classes with respect to dominated geological features. Again in the year 2000, Svec and Grigg made use of net pays in reservoir volume estimation to determining effective permeability value while Mathur et al. 2001, incorporated geochemical analysis of side-wall cores in net pay detection for the first time in history. In 2005, Worthington and Cosentino presented a comprehensive study on the role of cut-offs in determining net pays, in which they collected and summarized different combinations of cut-offs of shale volume, porosity, permeability, water saturation, resistivity and moveable hydrocarbon index (MHI), which are used in 31 previous investigations from 1980 to 2002, in which they finalized that cut-off values for different petrophysical features may lead to different identification of net pays .

Jensen and Menke 2006, developed a statistical method for determination of cut-offs in a manner that will minimize error during net to gross ratio calculation. Worthington etal., 2008, has also published a valuable paper that determines cut-offs dynamically with regard to depletion strategy. Singleton 2008, is the first researcher that investigated the detection of pay zones on seismic sections rather than wire-line well logs. A definition on different nets, especially net pay, was provided by Worthington 2010, in which the application of net pay in petroleum industry was extensively discussed.

Other author's (Liu, L. and Yager, R., 2008, Mahbaz etal., 2011, masoudi etal., 2011, Masoudi etal 2012a, Masoudi etal., 2012b, Masoudi etal., 2012c Masoudi, P., 2013 and Pedram Masoudi etal., 2014) have also investigated the various intricate and sophistication surrounding net pay evaluation.

Based on the prevailing uncertainty, this paper is of the view that there is no unique method to identify petrophysical cut-offs and therefore net pays. That is, cut-off values for different petrophysical features may lead to different identification of net pays, as it described by Worthington and Cosentino 2005, the selection of petrophysical features should be with regards to the purpose of application.

CONCLUSION

In this research, a representative static reservoir model was developed for an oil field based on geostatistical operation. Geophysical data was integrated and interpreted, which provides us the synthetics analyses, thereby making it a bases for structural maps validation. Geological data was also integrated and interpreted, which provides us with understanding of the stratigraphy, sedimentology as well as tectonics effect. These therefore shows that the Es4+Ek1 reservoir is made up of seven oil groups and five small layers in which the targeted fifth group is made up of 14 small layers. Facies analyses shows the presence of paleodelta plain distributary channel sand body, front water sand body, estuary dam sand body, sheet plain sand body and beach bar sand body. Based on the well to well correlation, Depositional Current direction is proved to be trending northeast to south west. Structural analysis revealed a series of faulting as a result of the tectonic activities in the region thus developing a favorable pattern for oil and gas distribution. Reserves estimation was carried out in which V-12 and V-13 present the highest value but presenting permeability of as low as 1.1mD while the V-12 and V-2 layers presents lower reserves and a relatively higher permeability of as high as 6.1mD. This work recommends the extension of seismic 3-D acquisition to the northwest and northeast limit of the studied area in order to develop the reserve growth potential **by a**pplying Extreme overbalanced surge acidizing techniques in order to increase permeability. Because of its ability to solve structural complexity, 3-D seismic data is recommended for application as an essential tool in future exploration and development across the entire Zhao 57 field. For future development of the field, authors strongly believe that the prime targets are the V-12 and V-13 layers.

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