Sudan University of Science and Technology
College of Petroleum Engineering and Mining
Exploration Engineering Department

Re-evaluation of well (Dalieb-1) in (Bentiu-AG2) formation in Abu Sufyan subbasin

إعادة تقيم بئر (1-Dalieb) في طبقتي (Bentiu-AG2) في حقل أبو سفيان الفرعي

Graduation project submitted in partial fulfilments for the degree of BSc (honor) in Exploration Engineering .

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الإستهلال

قال تعالى :

(وَلَئِنِ اتَّبَعْتَ أَهْوَاءَهُمْ بَعْدَ الَّذِي جَاءَكَ مِنَ الْعِلْمِ مَا لَكَ مِنَ اللَّهِ مِنْ وَلِيٍّ وَلا

نَصِيرٍ)

صدق اللّه العظيم

البقرة اية (120)

Dedication

She is precious in every way.

The source of kindness.

The sunshine's in my day.

The joy in my soul and the love of my life.

Mother

He's a role model and a source of strength and inspiration. He's the greatest man I've ever known and I'm so proud to be addressed with him.

Father

It's my second home where I belong.

I thank you for everything I learned inside you and what I've become.

Sudan University of science and technology

They are ones who share me my childhood and stand beside me while no one left aside.

Brothers and sisters

To whom I appreciate.

To whom I love and care.

My friends and classmates

For your patience,

caring, supporting and kind words sharing.

I just want to say thank you for everything along this period. Dear teachers

Acknowledgement

This research project would not have been possible without relief and the will of Allah and the support of many people; we would like to extend our deepest gratitude to our supervisor Mr Abubaker Alhaj for giving us the opportunity to our research. We greatly indebted to hem for his enduring confidence in us. We have learned many things from his rich academic and practical experience. He encouragement, support and patience always guided us throughout this period. We are also thankful especially Mr Abubaker Mohamed Shoaib, Eng Abdalhai, . for providing us their time and knowledge through teaching their wide practical experience in conducting software and how we can use it in our research project perfectly. and also we would like to thank everyone who extend a helping hand in the completion of this research project as well as members of the Department of Exploration Engineering.

Abstract

Reevaluate of the well (Dalieb-1) located in the Sufyan sub-basin in the northwestern part of the Muglad Basin in East Darfur State, Sudan. The seismic data were reinterpretation by four parallel and intersecting seismic lines. For petrophsiyecs properties we use IP software and re interpretation seismic data we use Petrel 2015 software .

التجريد

إعادة تقييم بئر (دليب 1) الواقع في حوض سفيان الفرعي في الجزء الشمالي الغربي من حوض المجلد شرق دارفور بالسودان.

تم إعادة تفسير البيانات الزلزالية من خلال أربعة خطوط زلزالية متوازية ومتقاطعة. بالنسبة للخصائص البتروفيزيائية تم إستخدام برامج IP software، وتم إستخدام Petrel 2015 software لإعادة تفسير البيانات الزلزالية .

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Chapter (1)

Introduction

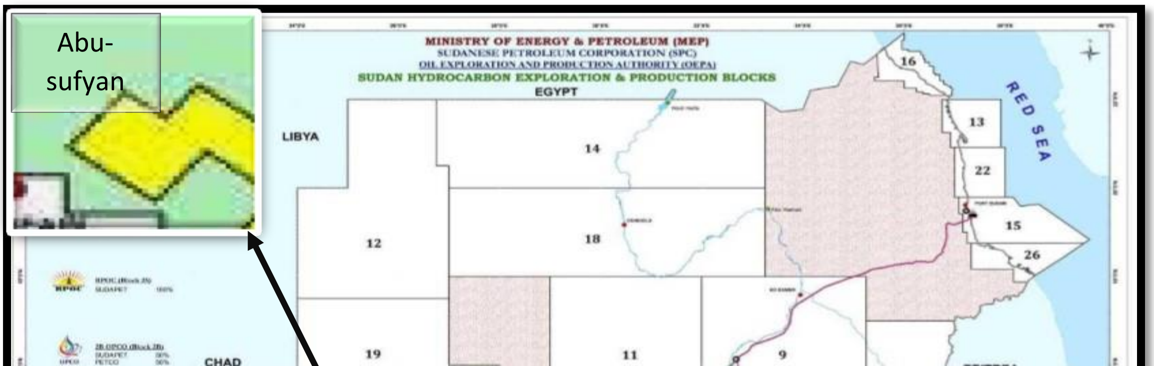
1.1 Background:

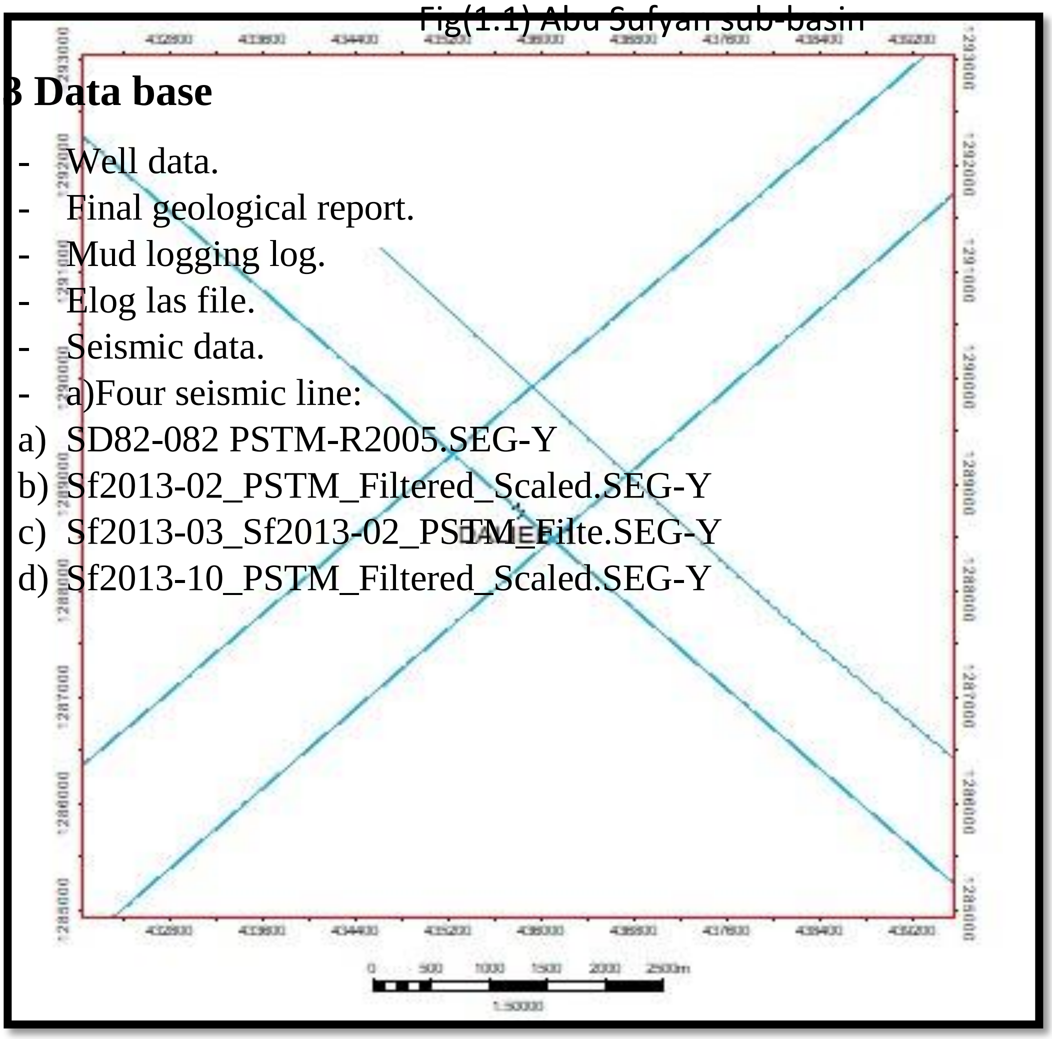
The Muglad Basin is a large rift basin in Northern Africa. The basin is situated within Sudan and South Sudan, The Muglad rift basin is up to 200 km wide and over 800 km long (i.e. ca. 160,000 km2 in area) and locally contains up to 13 km thick Cretaceous-Tertiary nonmarine sediments (El Hassan et al., 2017). It contains a number of hydrocarbon accumulations of various sizes, the largest of which are the Heglig and Unity oil fields.

The Sufyan Sub-basin is an east-west trending Sub-basin located in the north western part of the Muglad Basin, in the eastern extension of the West and Central Africa Rift System (WCARS). Exploration results showed the occurrence of accumulations of hydrocarbon. The source rock for these hydrocarbons is believed to be the lacustrine shale of the Abu Gabra Formation. Fluvio-deltaic sandstones within the Abu Gabra Formation represent the primary reservoir.

1.2 Location:

Dalieb-1 is wildcat well located in Abu Sufyan Sub-basin NW of Muglad Basin, in Western Sudan about 900 km from Khartoum.





Fig(1.1) Abu Sufyan sub-basin

1.3 Data base

- Well data.
- Final geological report.
- Mud logging log.
- Elog las file.
- Seismic data.
- a)Four seismic line:

a) SD82-082 PSTM-R2005.SEG-Y
b) Sf2013-02_PSTM_Filtered_Scaled.SEG-Y
c) Sf2013-03_Sf2013-02_PSTM_Filte.SEG-Y
d) Sf2013-10_PSTM_Filtered_Scaled.SEG-Y

Fig(1.2) Base map

1.4Objectives:

- Re-evaluate the well.
- Get the reason why its dry :

a) to avoid dry hole .

b) to increase the ratio of success in next exploration will.

- Increase the oil production.

Chapter (2)

Geological Background

2.1 Introdaction:

Rift basins of interior Sudan represent one of the major rift systems of the world. The deep Cretaceous – Tertiary basins form part of a regionally linked intracontinental rift system that crosses Central Africa (Fig. 1). The Muglad Basin is the largest of these NW – SE-oriented rift basins. The Muglad rift basin is up to 200 km wide and over 800 km long (i.e. ca. 160,000 km2 in area) and locally contains up to 13 km thick Cretaceous-Tertiary nonmarine sediments (El Hassan et al., 2017). The smaller Melut, Ruat, White Nile, Khartoum, Atbara and Blue Nile rifts are evident on regional gravity maps and parallel the NW – SE Muglad trend (Fig. 1). To the northwest, these rift basins appear to terminate against the Central African Shear Zone (CASZ), which extends from Cameroon through Chad to Sudan according to Fairhead (1988). However, some crustal extension may have occurred to the north of the CASZ in the vicinity of the Blue Nile Basin. The southeastern limit of the Sudan extensional system is poorly known. However, the Muglad and Melut Basins may coalesce southeastward and link up with the Anza Rift in Kenya.

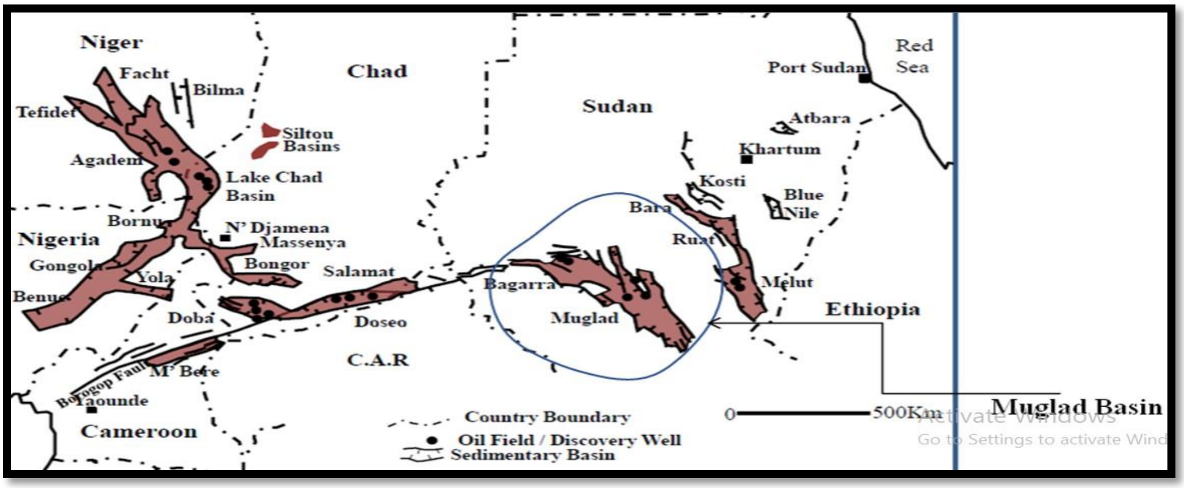


Fig. 2.1. Map showing the location of the Muglad Basin of Sudan as a part of the Central African Rift System (after Omatsola, 1987)

2.2 The Tectonic Evolution:

The south region of the Sudan affected by extensional tectonics that resulted several episodes of rifting along the early cretaceous up to the Oligocene.The Muglad basin evolution has been divided into (Shull,1988; Mohamed et al.,2001): Pre-rifting phase, Rifting phase, and Sag phase.

2.2.1 Shear zone :

The African continent is dissected by numcrous, linear, high-strain zones with predominantly N, NW and NE trends. Many of the Africa major lineaments are major ductile shear zones with large displacements occurring within tectnnic terranes (micro-plates), though often bounding orogcnic mobile belts separating the crayons, like the Limpopo belt in Botswana and Zimbabwe

These ductile shear zones represent a prominent feature in the northeast African, Late Protero -zoic (Pan-African) Nubian Shield (NS). Examples are the Nakasib, Oko and Keraf shear zones of Sudan; in addition to the Trans-African lineament (TAI, Nagy et al., 1976) also Known as Pelusium line (Neev, 1977), the Central African Shear zone and the Aswa Shear Zone.

2.2.2 Pre-rifting phase:

The region became consolidated platform during the Paleozoic and the early Mesozoic after the pan African Orogeny had ended at (550MA+-100M.Y), the near subsiding areas of the region have been supplied by poorly sorted and various types of sediments.

The Mesozoic plate tectonic link between the opening of the Atlantic Ocean and the development of the West and Central African Rift System (WCARS) via the Benue Trough and shear zones cutting Cameroon is not a new idea (Binks and Fairhead, 1992), nor is the polyphase development of the WCARS (Guiraud et al., 1992). What is new is the improved resolution and definition of the data sets used to establish the linkage.

2.2.3 Rifting phase:

Due to crustal extension relative to extensional tectonics three separated rifting phases had happened in the region extended through the early Cretaceous (135-96MA) and the late Cretaceous (96-65MA) to the Oligocene (33.7-23.5MA). These rifting phases provided the isostatic mechanism for subsidence which was accomplished by normal faulting parallel and sub parallel to the basinal axes and margin, each rifting phases activated in a certain period and followed by thermal subsidence. (Sayed, 2003; Elhaj, 2016)

2.2.4 Early rifting phase:

Early Cretaceous up to near the end of the Albian (108-96MA), simultaneously with the initial opening of the South Atlantic and the subsequent extension at the Benue Trough.Due to resulted shear movements,some basins developed within and in the immediate vicinity of the Cretaceous shear zones in the period from (120 – 90 Ma), these phase characterized by no volcanism is known to be associated.

2.2.5 Second rifting phase:

It had started in the Turonion (92-88MA) and continued up to the late Senonian (88.5-65AM). these rifting phase got risen due to tectonic effects of the changes in the opening of the southern Atlantic account for the late cretaceous period of shear movement in the west and central African rift system, these tectonic effects came as compressional stress at the Benue area and as dextral reactivation along Central African fault system during the late cretaceous time.The main evidence which the phase has left is in the southeast Muglad, the trend appeared to have been terminated and replaced by the northwest-southeast trending basins, which are extensional in their development.These phase differ from the last phase in that the second phase was accompanied by minor volcanism.

2.2.6 Final rifting phase:

Ithad initiated in the late Eocene (40-33.7MA) to the Oligocene (33.7-23.5Ma), approximately with the initial opening of the Red sea. There were evidences of volcanism.

2.2.7 Sag Phase:

Began in the middle Miocene (15.8-11MA) when the basinal areas entered an intracratonic sag phase of very gentle subsidence accompanied by little or no faulting. (Sayed, 2003)

. Sedimentary Setting:

The Muglad basin is filed with lower Cretaceous to Neogene sedimentary rock ranging in thickness from 6000 m to more than 13000 m were deposited in fluvial and lacustrine environment (USGS,2011). The sediments arelimited by Precambrian basement complex which are grandiorites encountered in Baraka-1 well and granitic basement encountered in Adilla-1 well. (RRI, 1991)

The sediment sequence has three cycles each one deposited during a certain rifting phase. The first cycle has deposited Sharaf-AbuGabra formations and Bentiu formation, the second cycle sediment have deposited Darfur group and Amal formation, the third cycle includes Kordfan group and end with Adok sandstone formation.The sediment sequence ended by the deposition of the late Miocene to recent Zaraf and Umm Ruwaba formations as post-rifting sediment.

2.3 Cycles of coarsening upward :

Based on the cyclic subdivision of the “Nubian Sandstone” of NW Sudan, the sedimentary rocks of the Muglad Basin belong to the upper or the Nubian Cycle. The following accounts, which are on the stratigraphy and sedimentology of the Late Jurassic/Early Cretaceous–Tertiary strata were summarized after (Schull, 1988 &Kaska, as a result to the repeated rifting, subsidence and sedimentation, three coarsening upward cycles have formed

2.3.1 Precambrian basement rocks:

This interval is mainly represented by crystalline basement predominantly metamorphic rocks, with limited igneous intrusions .

From the Cambrian to the Mesozoic, the area was an extensive continental platform which had become consolidated and stabilized by the end of the Pan-African episode (Schull, 1988). In the subsurface, basement rocks were reached in few wells drilled in basement highs or at the periphery of the basin.

2.3.2 Mesozoic - Cainozoic strata:

2.3.2.1 Sharaf Formation (Jurassic / Neocomian-Barremian);

The oldest penetrated sedimentary rocks in the Muglad Basin are non-marine Jurassic or Lower Cretaceous strata of the Sharaf and Abu Gabra Formations. The Sharaft Formation was originally named by Schull (1988) to represent the early graben-fill clastic sediments derived from the gneissic basement complex during the early phases of rifting. The formation consists of claystones, siltstones, and fine-grained sandstones deposited in fluvial floodplain and lacustrine environments and rest unconformably on the basement rocks Tentative ages of late Jurassic to Neocomian have been assigned to the proto-rift or aborted rift sediments below the Abu Gabra Formation (BeicipFrar which seem to exist above lab, 2004). However, palynological evidence (Kaska, 1989) indicated a Neocomian-Barremian age for the Sharaf Formation, a unit that underlies the Abu Gabra Formation. Recent studies consider the Abu Gabra and Sharaf Formations as one lithostratigraphic unit, since no significant difference exists.

2.3.2.2 Abu Gabra Formation (Neocomian-Barremian/ early Aptian):

This unit represents the early phase of lacustrine environment with thousands of metres of organic-rich claystones and shale deposits interbedded with fine-grained sandstones and silt- stones locally overlies the Sharaf Formation or unconformably rests on the basement rocks. However, sediments of older age might well exist in the deepest troughs of the basin. The clay- stones and shale represent the main petroleum source rocks in the Muglad Basin. Based on spore and pollen assemblages, the Abu Gabra Formation is dated as Neocomian- Aptian corresponding to Assemblage Zones I and II of Awad .

The palynofacies types of this formation is dominated by palynomorphs, freshwater algae and amorphous organic matter reflecting an alternating environments from very near-shore in the lower parts of the formation to an open lacustrine towards the upper parts.

2.3.2.3 Bentiu Formation (Aptian-Cenomanian):

The Abu Gabra Formation is in parts unconformably overlain by the Lower Bentiu Formation, the latter comprises a massive sandstone sequence with some thin claystone interbeds. This unitrepresents the main reservoir rock in the Muglad Basin.

The Bentiu Formation corresponds to the biostratigraphic units designated as Zones II, III and IV.

The unit was deposited mainly under alluvial and fluvial (braided and partially meandering streams) environments. The palynofacies is dominated by common occurrence of well-preserved humic debris, vitrinite and structured inertinite together with prominent cutinite and palynomorphs (common Classopollis spp.) reflecting high energy environment.

2.3.2.4 Aradeiba Formation (Coniacian-early Santonian) :

This is the oldest unit of the Darfur Group, which corresponds to Zone IV and part of Zone V (Awad, 1999). This lithostratigraphic unit is separated from the underlying Upper Bentiu For- mation by a basin-wide unconformity, which spans the Turonian time (table 2.1). Core data analysis suggests deposition in a fluvial channel complex and possibly deltaic distrib- utary channels (Abbas, 2012). The coarsening upward succession of cross-bedded to massive sandstones with finer-grained sands and silts are likely to represent a sequence of distributary mouth bars and sand bar deposits. The mudstones and siltstones possibly represent pro-delta or over bank deposits. Log motif analyses of the Aradeiba Formation frequently show a com- bination of basin floor fans, channel fill deposits, high sinuosity streams with point bars and floodplain deposits (table 2.1) ; Awad, personal communication). Aradeiba sands are important reservoirs in the Unity and Heglig oilfields. Palynofacies charac- terized by few spores/pollen grains, black wood remains, brown to dark structureless organic matter (SLOM), few cuticles indicate deposition in high energy near shore settings.

2.3.2.5 Zarqa Formation (late Santaonian) :

The second unit in the Darfur Group is the Zarqa Formation which consists of interceded sequences of mudstones, sandstones and siltstone, which becomes more argillaceous towards the basin center. The formation has been identified in all wells of southeast Mug lad Basin, particularly in the Unity and Heglig Fields with variable thickness ranging between 50-315 m (RRI and GRAS, 1991). Similar to the Aradeiba Formation, the Zarqa Formation was deposited in a lacustrine environment with fluvial-deltaic channels (RRI and GRAS, 1991). In support of the predominantly lacustrine setting, the freshwater algae Pedi strum spp., consistently recorded.

2.3.2.6 Ghazal Formation (Campanian) :

This unit is characterized by high percentage of sand which is moderately heterogeneous due to interbedded shale intervals throughout the reservoir. The lithological composition and paly- nofacies association of the Ghazal Formation are similar to that of the Zarga Formation, but its thicker sand indicates deposition in braided streams. The upper part of the formation has relatively lesser sands content assuming a fining-upward sequences buildup of parasequences, each of which starts with scour surface and lag deposits characteristic of meandering.The unit partially corresponds to Zone VI and to Zone V .

2.3.2.7 Baraka Formation (Maastrichtian) Baraka :

Formation is the topmost unit of the Darfur Group which consists of sands and sand-stones with thinly interbedded silty claystones. The sandstonesare dominantly fine- to coarse- grained and occasionally very coarse-grained. Unlike the other members of the Darfur group, the Baraka Formation does not contribute to the reservoir zones in the Unity and Heglig Fields, due to the absence of adequate sealing (RRI and GRAS, 1991). The thickness of the formation in the southeastern part of the Muglad Basin ranges between 40-100m. Palynofacies associa- tion is composed mainly of black wood remains, brown to dark degradedstructureless organic matterwith few plant tissues and cuticles reflecting a well-oxygenated environment. The Baraka Formation corresponds to Zone VII (Awad, 1999) and Zone VI (Eisawi et al., 2012; table 2.1) which indicate Maastrichtian age.

2.3.2.8 Amal Formation (paleocene) :

The second cycle ended with the deposition of the Amal Formation which consists of thick mas- sive sandstones deposited in alluvial fans and braided streams environments. The palynofacies association derived from this unit consists of abundant dark structured organic matter reflecting deposition in high energy settings. Spores/pollen assemblage indicates that the unit corresponds to Zone VII (Awad, 1999) or otherwise Zone V (Stead and Awad, 2005 table 2.1); therefore a Paleocene age has been assigned to the formation.

2.3.2.9 Nayil Formation (Eocene- early Oligocene) :

The unit represents the syn-rift part of the third rifting phase. It is dominated by claystones deposited in fluvial/floodplain and lacustrine environments.

The palynofacies of the Nayil Formation is characterized by greater palynomorph recovery reflecting low energy open lacustrine en-viroment. The unit corresponds to Zone IX (Awad, 1999) and Zone 4 (Stead and Awad, 2005; table 2.1). Accordingly , an age of ecoene- early Oligocene has been ass igned to the formation.

2.3.2.10 Tendi Formation (late Oligocene-early Miocene) :

The Tendi formation is similar in composition to the underlying) Nayil Formation. This unit is Characterized by remarkable palynomorphs recovery (spore, pollen and algae) with structured organic matter which indicates open lacustrine environment .The unis corresponds to Zone X (Awad, 1999) and Zone 3 (Stead and Awad, 2005:table 2.1).Accordingly, an age of late Oligocene-early Miocenehas been assigned to the unit.

2.3.2.11 .Adok Formation (late Miocene-Pliocene) :

This unit consists of sand and sandstones, fine to coarse-grained. Widely recognized throughout the Muglad Basin. Palynofacies assemblage consists of ew spores, common structured organic matter and subordinate woody material indicating more distal setting of the lake. The unit corresponds to Zone XI (Awad, 1999) and Zone 2 (Stead and Awad, 2005 table 2.1).Consequently, a late Miocene - Pliocene age has been assigned to the Adok formation.

2.3.2.12 Umm Ruwaba Formation (holocene) :

This unit is the most widespread in south-central Sudan basins; it consists of unconsolidated semi-consolidatcd gravels, sands, clayey sands and clays of fluvial and lacustrine environments .

(.EI Shafie, 1975). The sediments of the Umm Ruwaba Formation generally show rapid facies change which makes the lateral correlation somewhat difficult.

Table 2.1: Comparison between stratigrabhic schemes of Muglad Basin

Age (Ma)	Temporal Units		Lithostratigraphic Units			Biostratigraphic Units			
	System/ Period	Series/ Epoch	Schull (1988)		Awad (1999)	Kaska (989)	Awad (1999)	Eisawi et al. (2012)* Stead & Awad (2005)**	
	Quaternary	Holocene	Kordofan Group	Zeraf	Umm Ruwaba	E		1	
1.81		Pleistocene			Zeraf				
5.33	Neogene	Pliocene			Adok		XI	2	2a
		Miocene							2b
23.03				Adok	Tendi	??	X	3	3a
	Palaeogene	Oligocene		Tendi					3b
33.90		Eocene		Nayil	Nayil	D	IX	4	4a
55.80									4b
		Palaeocene	Amal				VIIIA	5	5a

Chapter (3)

Methodology

3.1INTRODUCTION:

Re evaluation petrophysical properties by IP software and re interpretation seismic data by Petrel 2015 on the praimary target Bantiu and AG2 formations.

3.1.1Interactive petrophysics:

Re-evaluation Petro physical prorates reinterpretation represents one of most essential process to understand reservoir properties in subsurface structures, geological formation, and physical measurement. This process was used to identify Petrophysical properties which related to interpretations and corrections of well log records. The well log related to samples which can be obtained in to subsurface. Reservoirs are subdivided in to several units or zones depends on various Petrophysical properties (primary and secondary porosity, lithology, permeability, fluid saturation, mineralogy

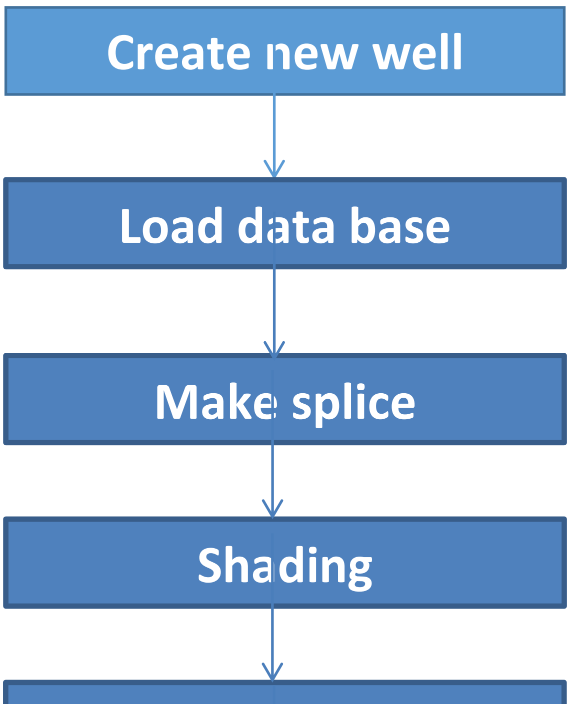
3.1.2Petrel Software:

Petrel software version 2015 has been used for this research. This software is window based and assets of Schlumberger. Petrel can perform various operation, including interpretation of seismic data, well correlation; also it can generate reservoir models, calculation of volumes …etc.

The Petrel user has the option to choose between manual and automatic interpretation, for which both act as freely interpretation or with guidelines respectively. If automatic interpretation of horizons is used, one of three functions should be elect; guided auto tracking, 2D auto tracking or 3D auto tracking, which all required an important parameter that defining the degree of the seismic event is to be followed. For "good", continuous reflectors such as the sea floor, one can have loose constraints, whereas for more chaotic events such as failed slide deposits stricter constraints are suggested. It is possible to choose which part of the signal is to be followed: the lower zero crossing or upper zero crossing, peak or trough …et

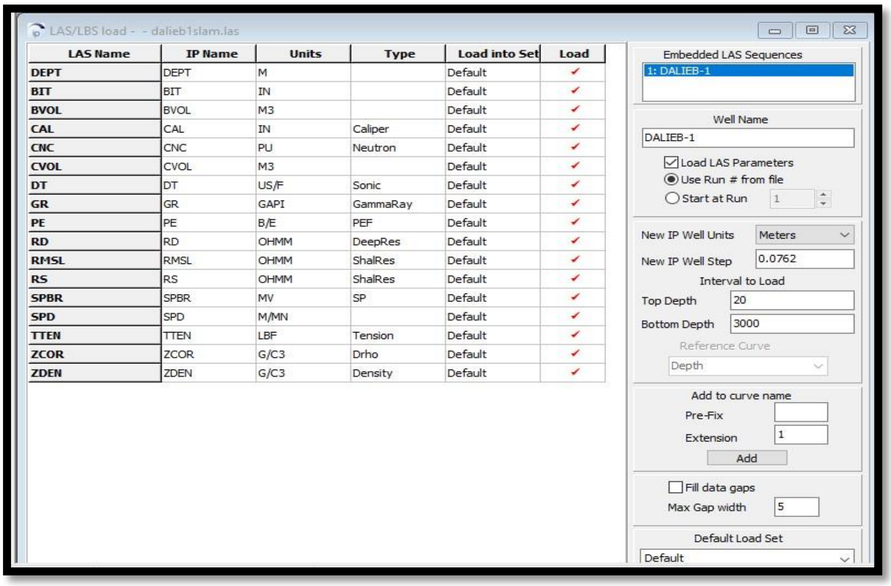
3.2 Interactive petrophysics:

3.2.1 IP work flow :



3.2.2 Laod LAS file:

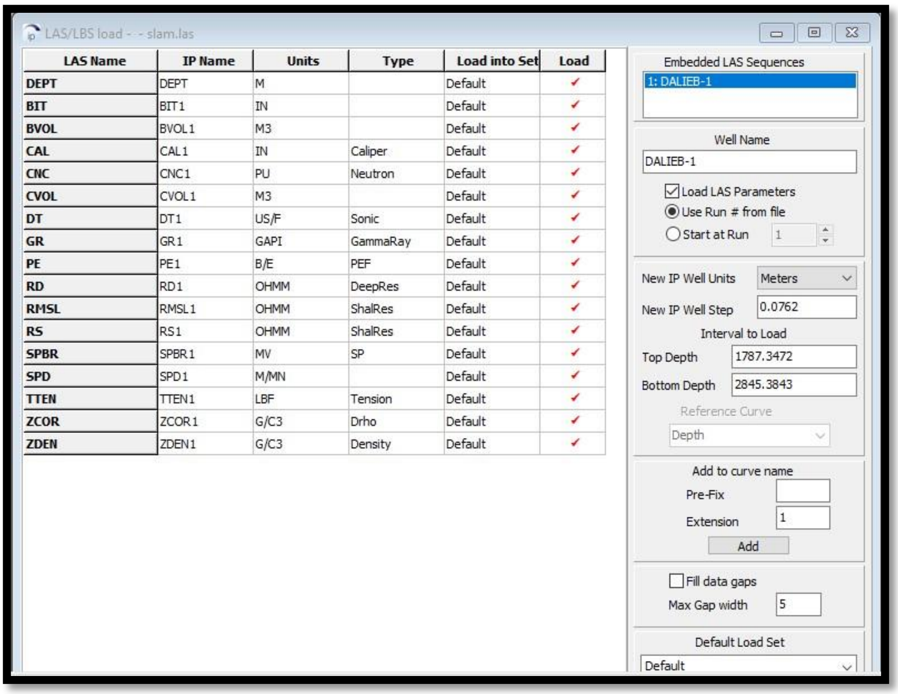
3.2.3 Dalieb 1 salam



LAS Name	IP Name	Units	Type	Load into Set	Load
DEPT	DEPT	M		Default	✓
BIT	BIT	IN		Default	✓
BVOL	BVOL	M3		Default	✓
CAL	CAL	IN	Caliper	Default	✓
CNC	CNC	PU	Neutron	Default	✓
CVOL	CVOL	M3		Default	✓
DT	DT	US/F	Sonic	Default	✓
GR	GR	GAPI	GammaRay	Default	✓
PE	PE	B/E	PEF	Default	✓
RD	RD	OHMM	DeepRes	Default	✓
RMSL	RMSL	OHMM	ShalRes	Default	✓
RS	RS	OHMM	ShalRes	Default	✓
SPBR	SPBR	MV	SP	Default	✓
SPD	SPD	M/MN		Default	✓
TTEN	TTEN	LBF	Tension	Default	✓
ZCOR	ZCOR	G/C3	Drho	Default	✓
ZDEN	ZDEN	G/C3	Density	Default	✓

fig (3.1)

Salam.las2



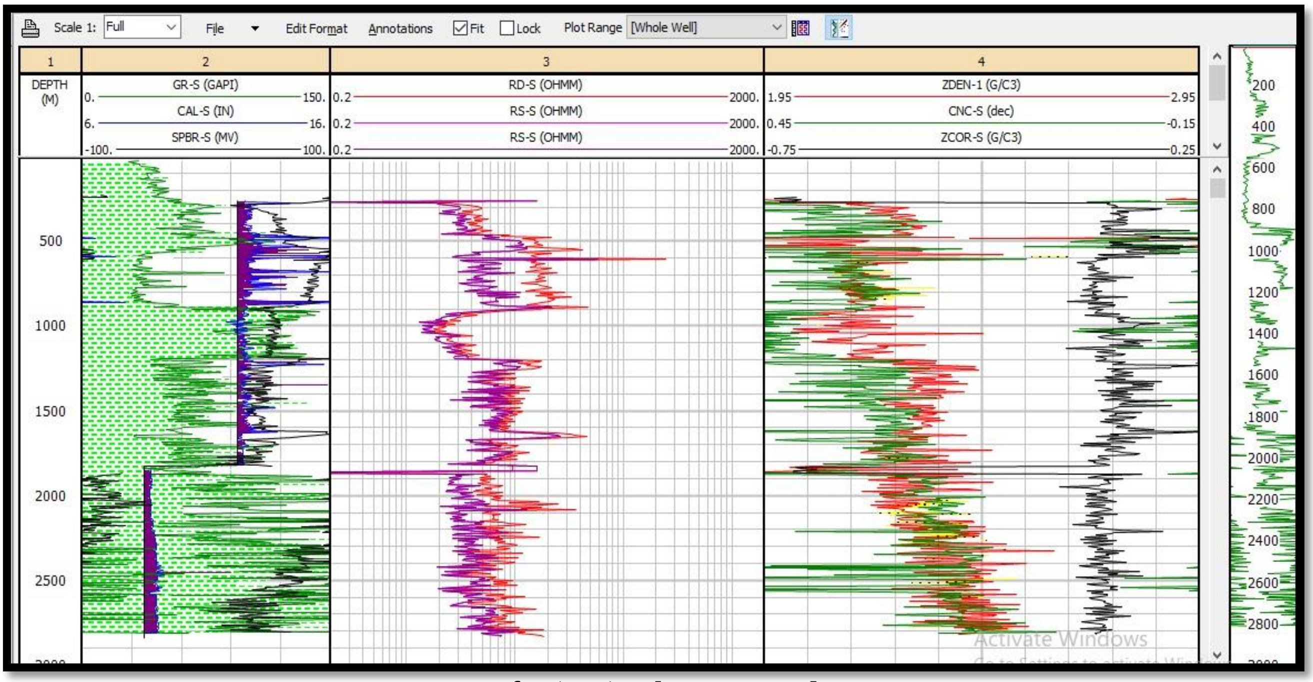
LAS Name	IP Name	Units	Type	Load into Set	Load
DEPT	DEPT	M		Default	✓
BIT	BIT1	IN		Default	✓
BVOL	BVOL1	M3		Default	✓
CAL	CAL1	IN	Caliper	Default	✓
CNC	CNC1	PU	Neutron	Default	✓
CVOL	CVOL1	M3		Default	✓
DT	DT1	US/F	Sonic	Default	✓
GR	GR1	GAPI	GammaRay	Default	✓
PE	PE1	B/E	PEF	Default	✓
RD	RD1	OHMM	DeepRes	Default	✓
RMSL	RMSL1	OHMM	ShalRes	Default	✓
RS	RS1	OHMM	ShalRes	Default	✓
SPBR	SPBR1	MV	SP	Default	✓
SPD	SPD1	M/MN		Default	✓
TTEN	TTEN1	LBF	Tension	Default	✓
ZCOR	ZCOR1	G/C3	Drho	Default	✓
ZDEN	ZDEN1	G/C3	Density	Default	✓

Fig (3.2)

In this well there are two las first one from 20 to 3000, second las from 1787.3472 to 2845.3843,load las one (salam1) and (dalieb 1 salam) and make QC and splice.

3.2.3QC Splice Las1 & Las 2 and view triple compo:

Making splice depending on the point of overlap between two las or trending, to linked two las in one las file.



fig(3.3); showing splice.

3.2.4 Laod formation Tops in new track :

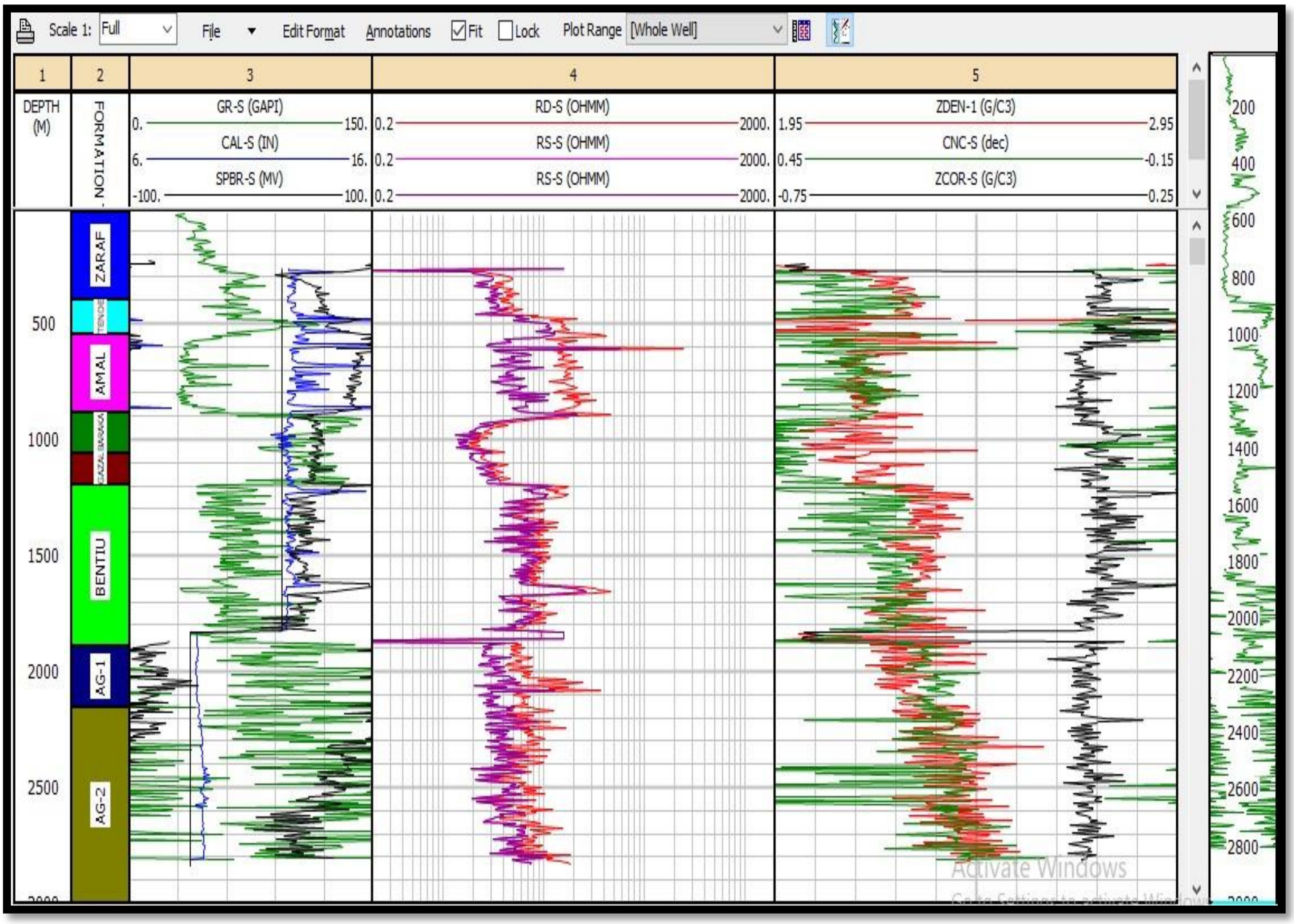


Fig (3.4)

3.2.5 Calculate clay Volume:

model for tertiary rocks:

$$VSH_{\mathrm{LinearGrIndex}} = IGR = \frac{GR_{\mathrm{LogSignal}} - GR_{\mathrm{CleanRock}}}{GR_{\mathrm{Shale}} - GR_{\mathrm{CleanRock}}}$$

IGR= gamma ray index.

VSH = shale volume

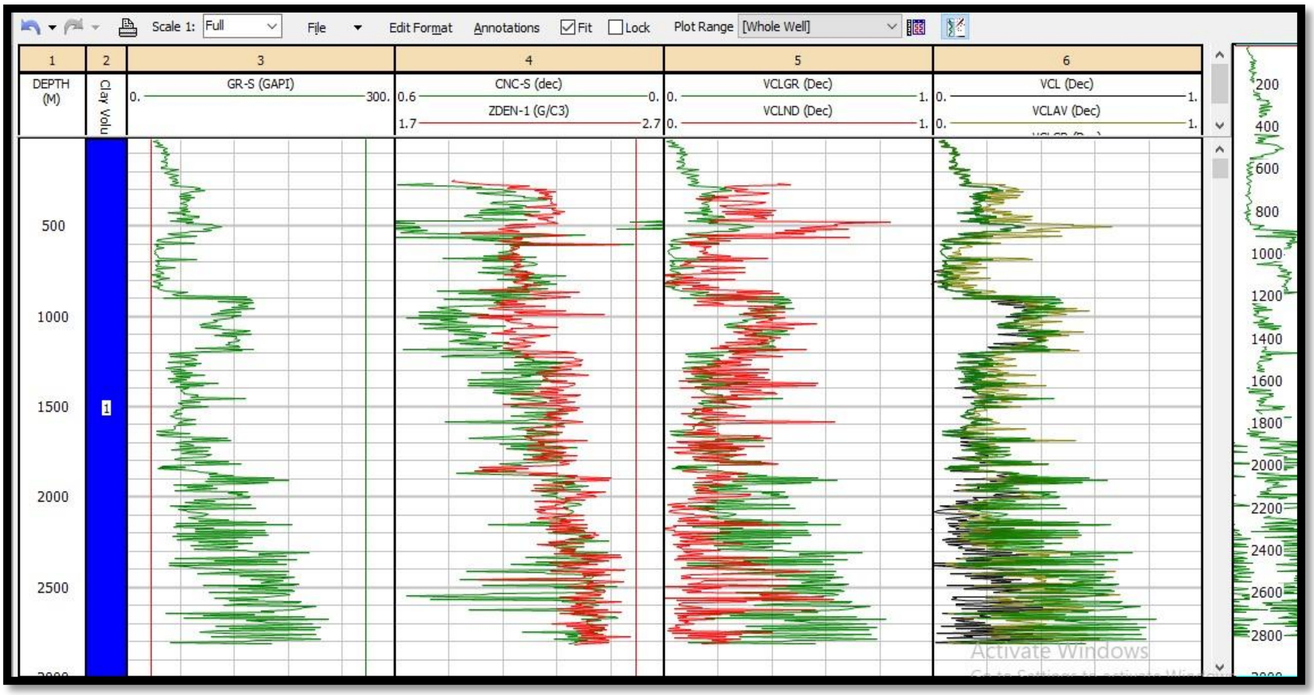


Fig (3.5)

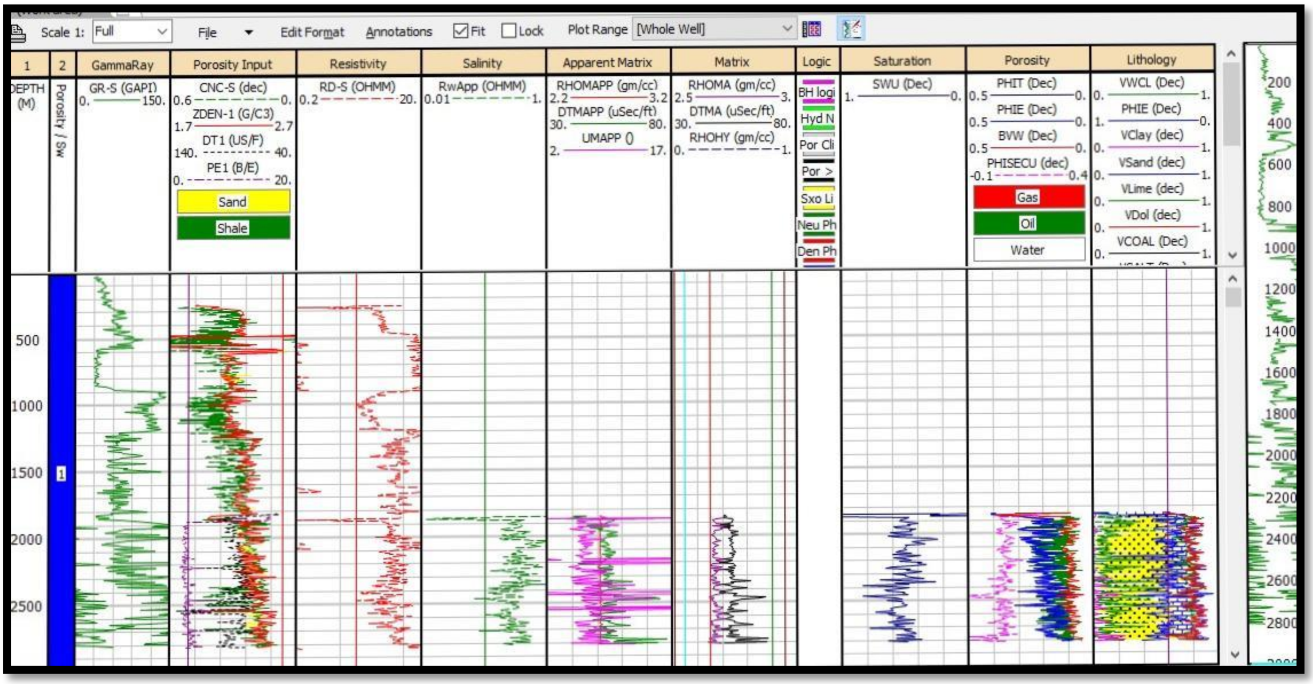
Calculate SW, property, resistivity By Indonesian equations

- Indonesian equation:

$$S_w = \left\{ \left[\left(\frac{V_{sh}^{2-V_{sh}}}{R_{sh}} \right)^{1/2} + \left(\frac{\phi_e^m}{R_w} \right)^{1/2} \right]^2 R_t \right\}^{-1/n}.$$

- Where
- **Sw** = water saturation of formation
- **Rt** = True resistivity (log reading)
- **Vsh** = volume of shale
- **Rsh** = resistivity of shale (log reading)

Rw = resistvity of formation water (computed from pickett plot)
Φe = effectivity prosity (computed from sonic log)
m = cementation factor (pickett plot)
a = Archie constant (0.68 for sandstone)
n = Saturation exponent



Fig(3.6)

3.2.6 calculate water saturation:

water saturation calculated by using Indonesian equation, The Indonesia equation may work well with fresh formation water. The parameter Rshale (resistivity of shale) is usually taken from the resistivity reading of a nearby pure shale, assuming that the clay cements & silt, and the shale nature, are similar to those of the shaly sand.

3.3 seismic interpretation:

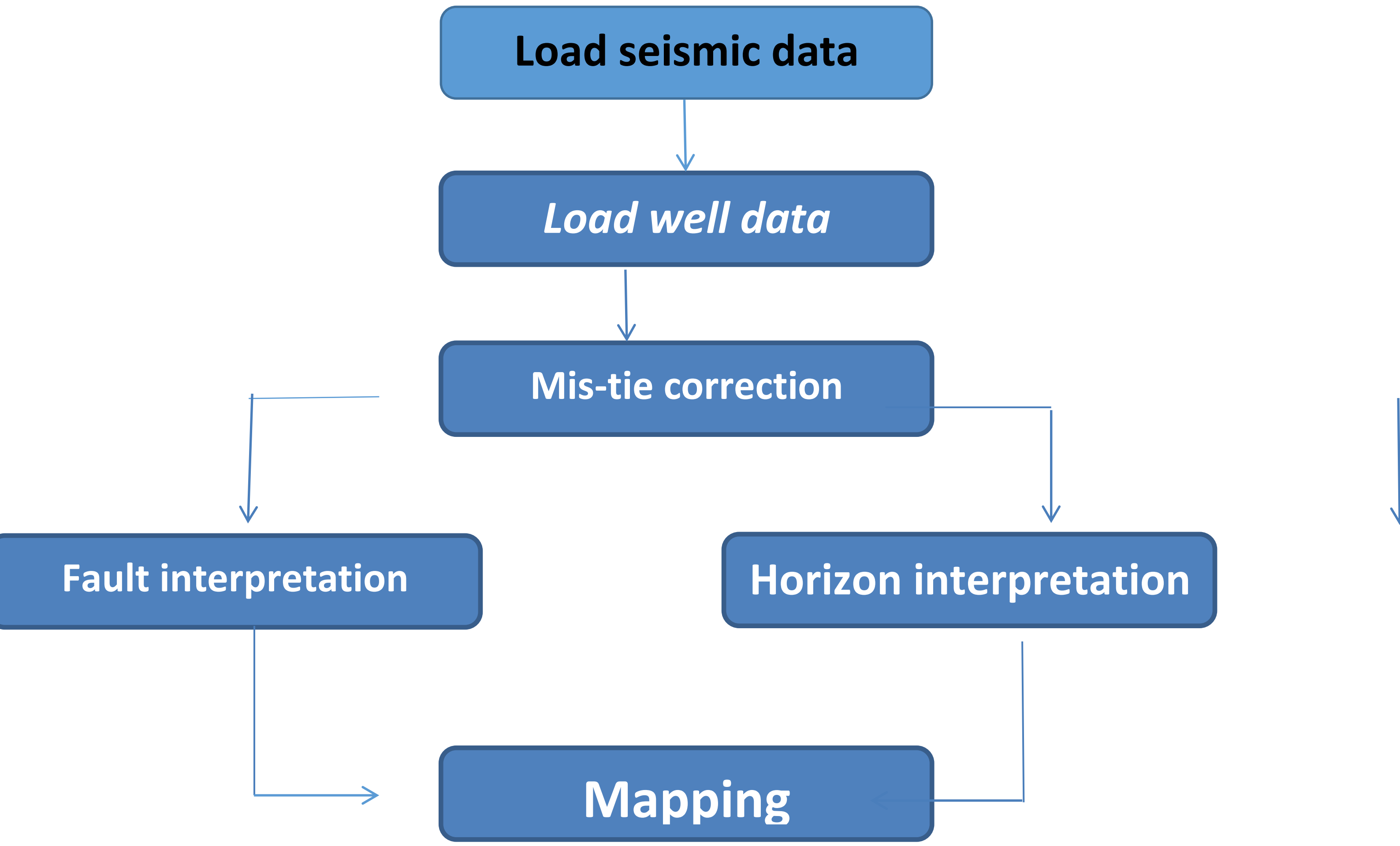
seismic interpretation is doing by petrel software.

3.3.1Petrel Software:

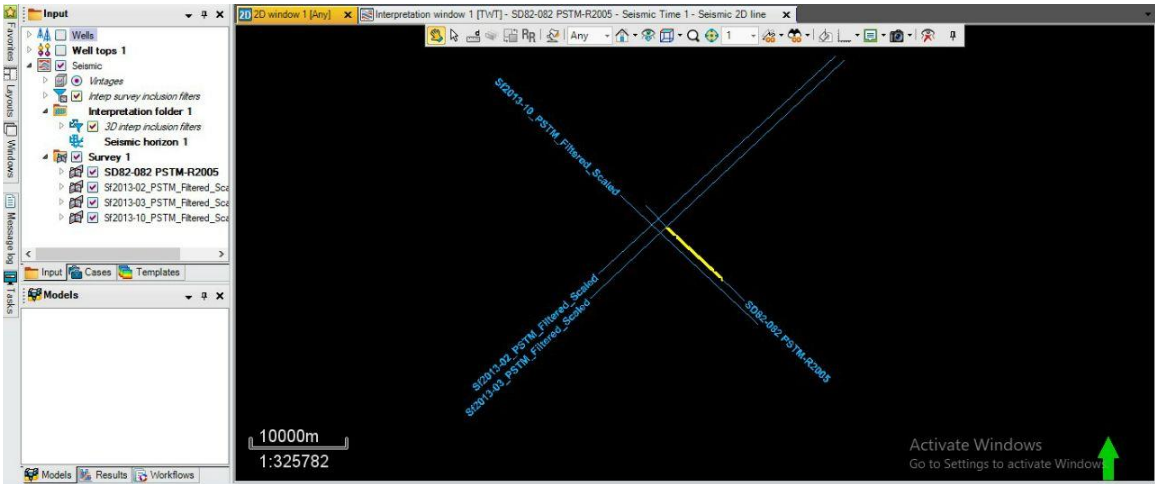
Petrel software version 2015 has been used for this research. This software is window based and assets of Schlumberger. Petrel can perform various operation, including interpretation of seismic data, well correlation; also it can generate reservoir models, calculation of volumes …etc.

The Petrel user has the option to choose between manual and automatic interpretation, for which both act as freely interpretation or with guidelines respectively. If automatic interpretation of horizons is used, one of three functions should be elect; guided auto tracking, 2D auto tracking or 3D auto tracking, which all required an important parameter that defining the degree of the seismic event is to be followed. For "good", continuous reflectors such as the sea floor, one can have loose constraints, whereas for more chaotic events such as failed slide deposits stricter constraints are suggested. It is possible to choose which part of the signal is to be followed: the lower zero crossing or upper zero crossing, peak or trough …etc.

3.3.2 Work flow:



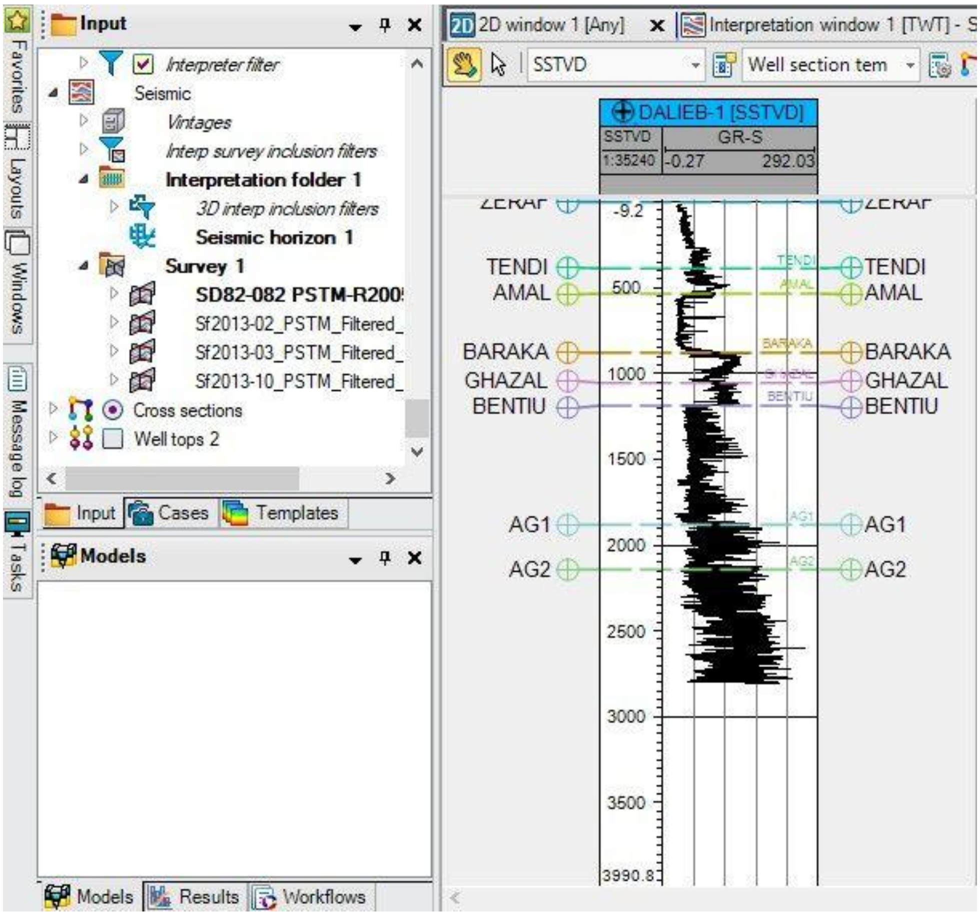
3.3.3 Load seismic data:



Fig(3.7); seismic lines in 2D window.

3.3.4 Load well data:

Load well data and formation tops in section window.

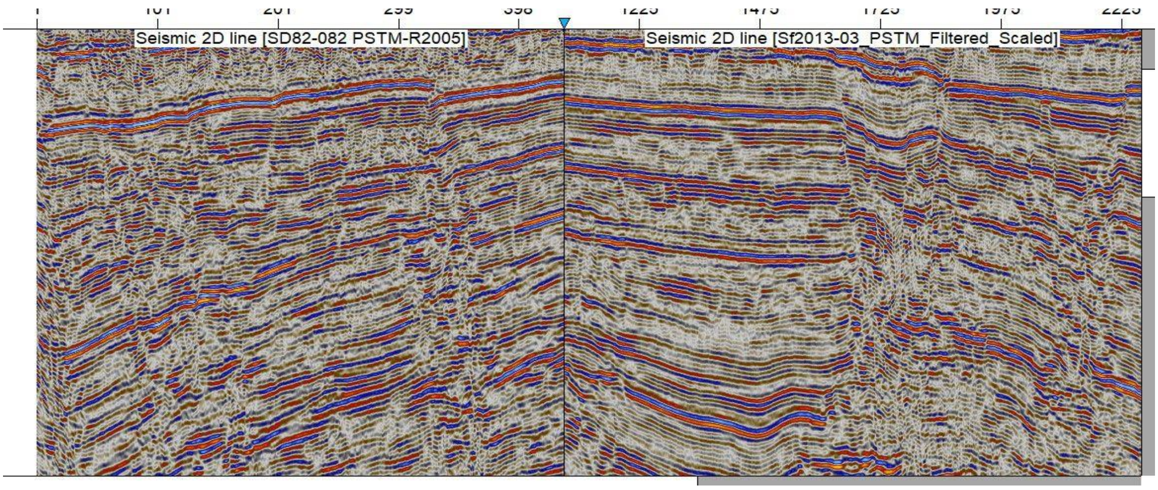


Fig(3.8); well data.

3.3.5 Mis-tie correction:

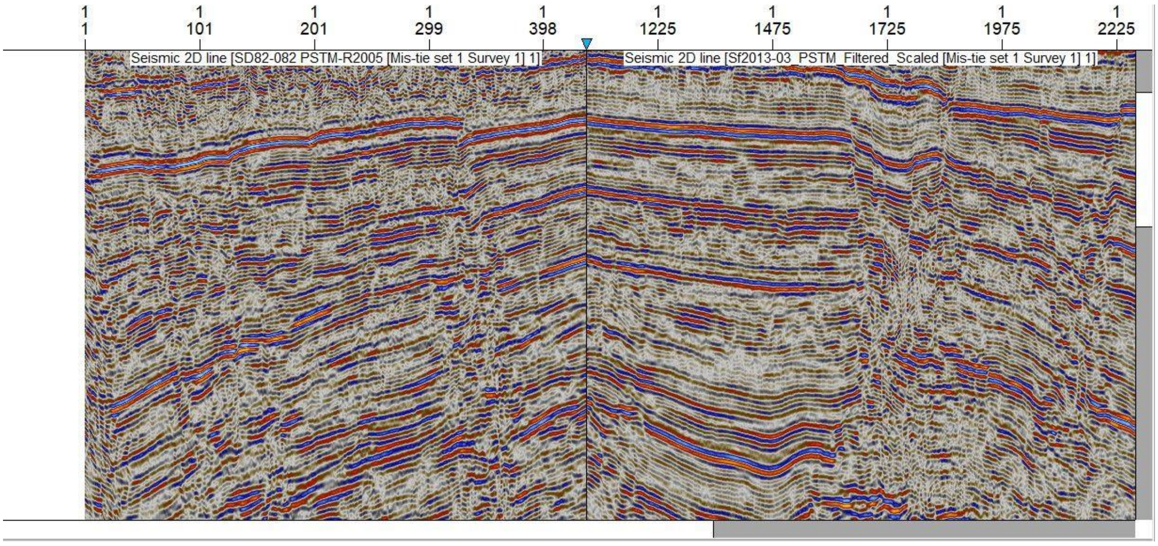
The mis-tie correction is an important task since the mis-ties make comprehensive interpretation inaccurate. In this paper, we firstly describe the theory and algorithms to compute seismic amplitudes, time and phase differences at each intersection point, then give some mis-tie correction results through synthetic and real seismic data. The results show that the presented mis-tie correction methods are correct and efficient.

Pefor mis-tie correction;



Fig(3.9); Original composite seismic.

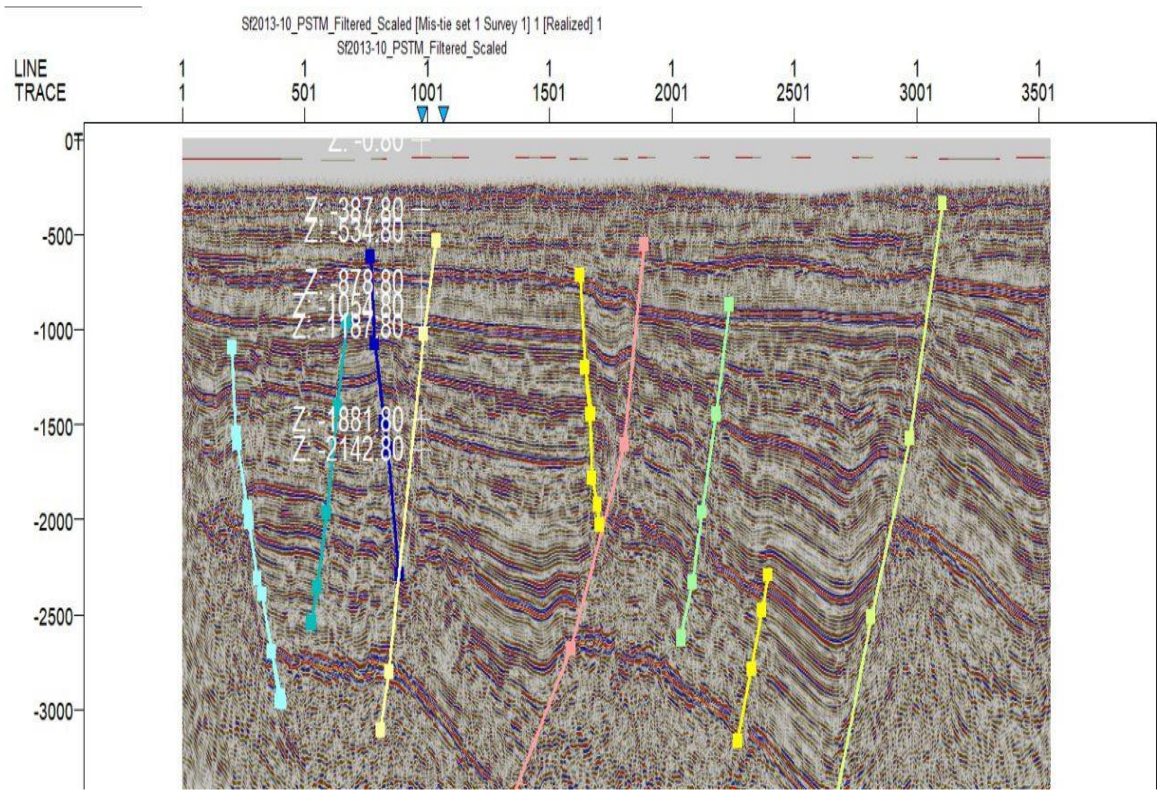
After mis-tie correction;



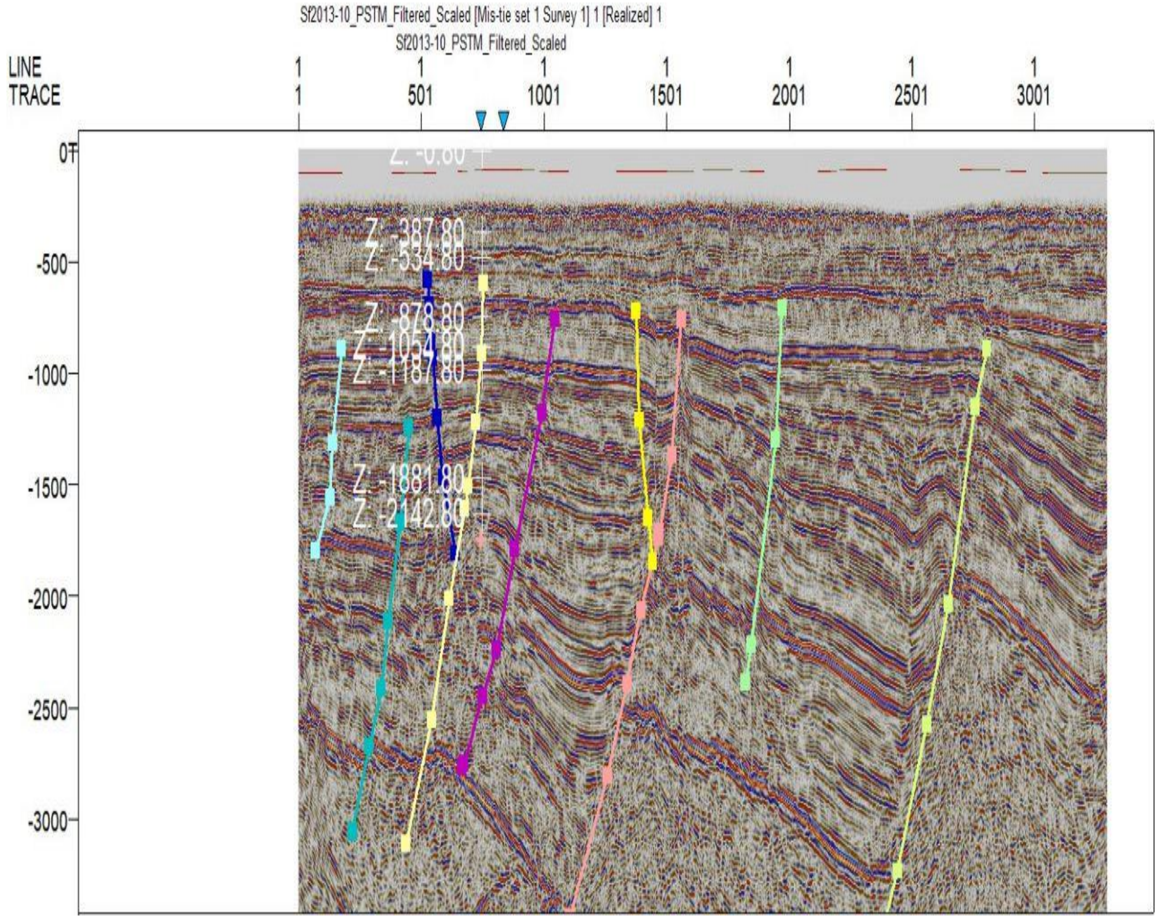
Fig(3.10); corrected composite seismic by check-shot.

3.3.6 Fault interpretation:

Fault interpretation can do it by petrel software. The Petrel user has the option to choose between manual and automatic interpretation, after choose we make Fault interpretation for each line and linked each fault with same one in other line .

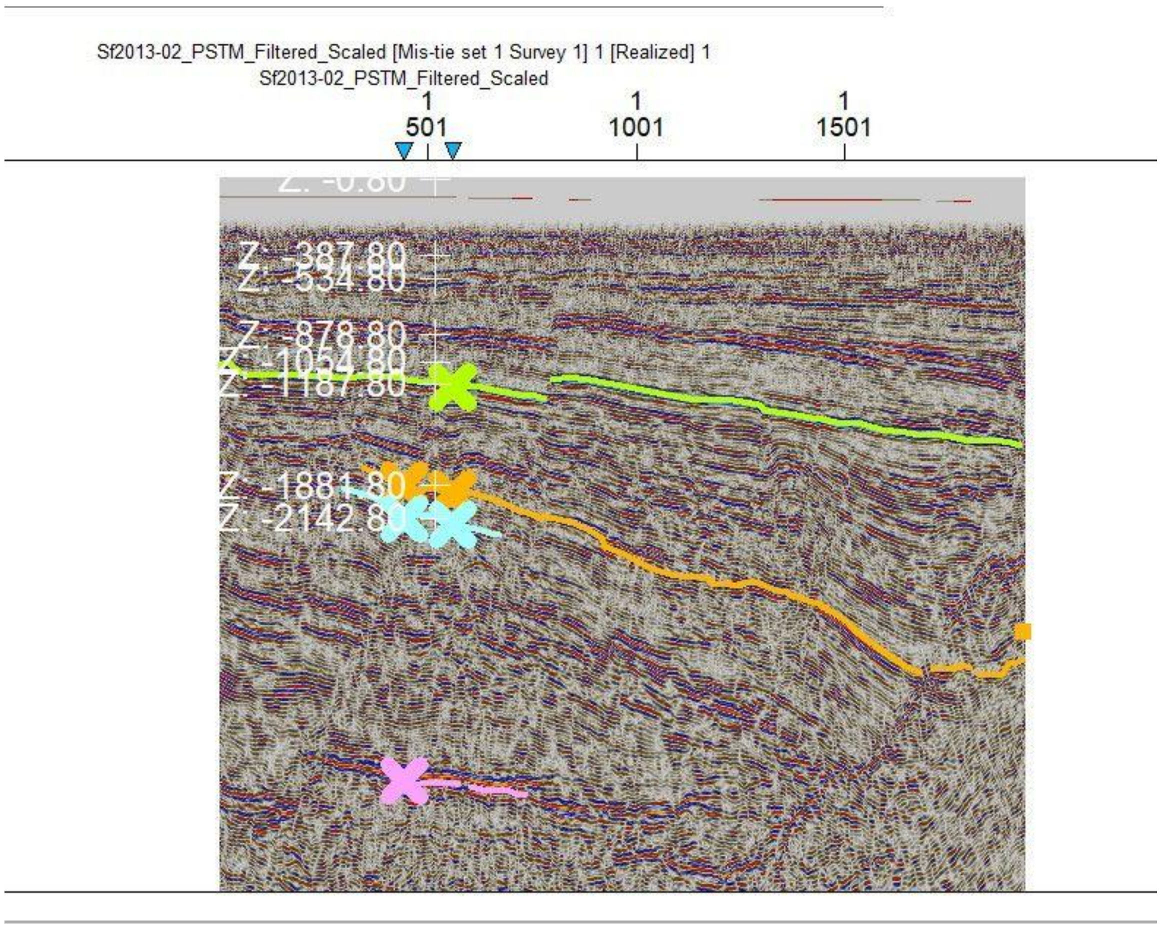


Fig(3.11); Fault interpretation for line Sf2013-10_PSTM_Filtered_Scaled.SEGY

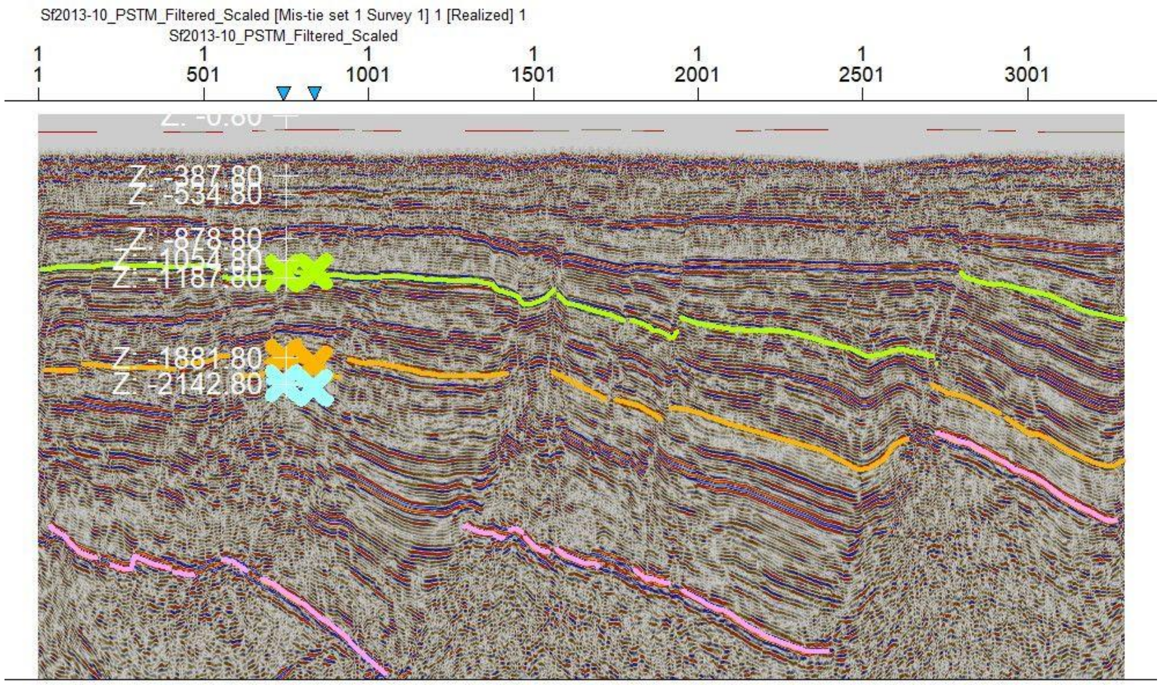


Fig(3.12); Fault interpretation for line Sf2013-10_PSTM_Filtered_Scaled.SEGY.

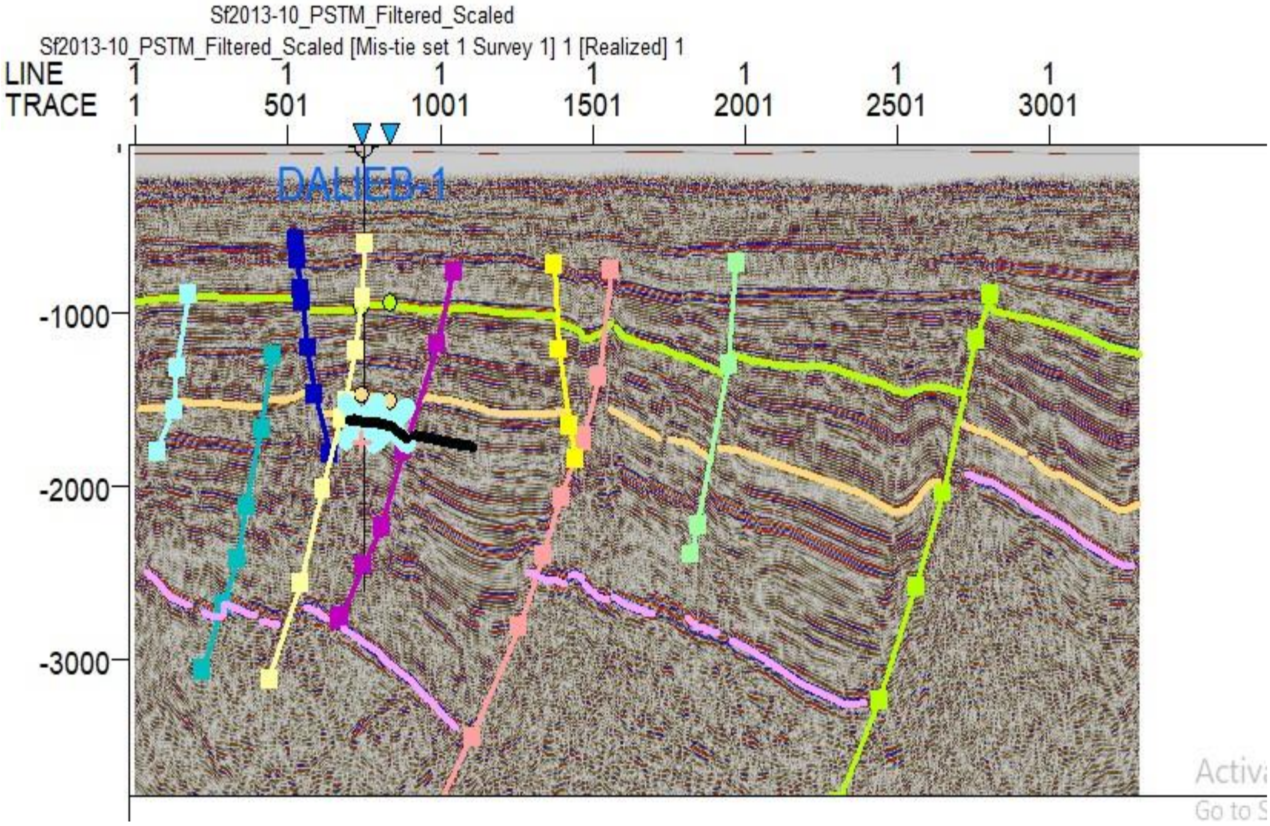
3.3.7 Horizon interpretation:



Fig(3.13); horizon picking for line Sf2013-02_PSTM_Filtered_Scaled.SEGY .



Fig(3.14); horizon picking for line Sf2013-10_PSTM_Filtered_Scaled.SEGY.



Fig(3.15); Fault and horizon picking for line Sf2013-10_PSTM_Filtered_Scaled.SEGY

Chapter (4)

Interpretation

4.1 Introduction :

Dalieb-1 is proposed as a vertical wildcat to evaluate the hydrocarbon potential of Dalieb Structure. The primary target is AG2-Oil Formation. The secondary Target is Bentiu.

We reevaluate petrophesical properties and re interpretation the seismic data of the target area on Bantiu and AG2

4.2Bantiu formation (1197m-1891m)

4.2.1Final geological report mud logging :

The Bentiu formation in Dalieb-1 is made up of medium to coarse grained, sandstones, interbedded with grey to redish brown claystones. The sandstones form 58.9% of this formation; the claystones form 41.1% of this formation.

a-SANDSTONE:

translucent to transparent, rare light grey, unconsolidated, medium to coarse grained, minor very coarse graind, trace fine grained, rare gravle, subrounded to subangular, minor angular, trace rounded, moderately sorted, quartz, trace argillaceous matrix, rare to trace kaolinitic cement, good porosity, trace fair porosity.

b-CLAYSTONE:

grey to redish brown, occasionally greenish gray, trace greenish grey, rare light gray, moderately hard, occasionally firm, sub blocky to blocky. There were no fluorescent shows observed in this unit.

4.2.2Petrophysics interpretation :

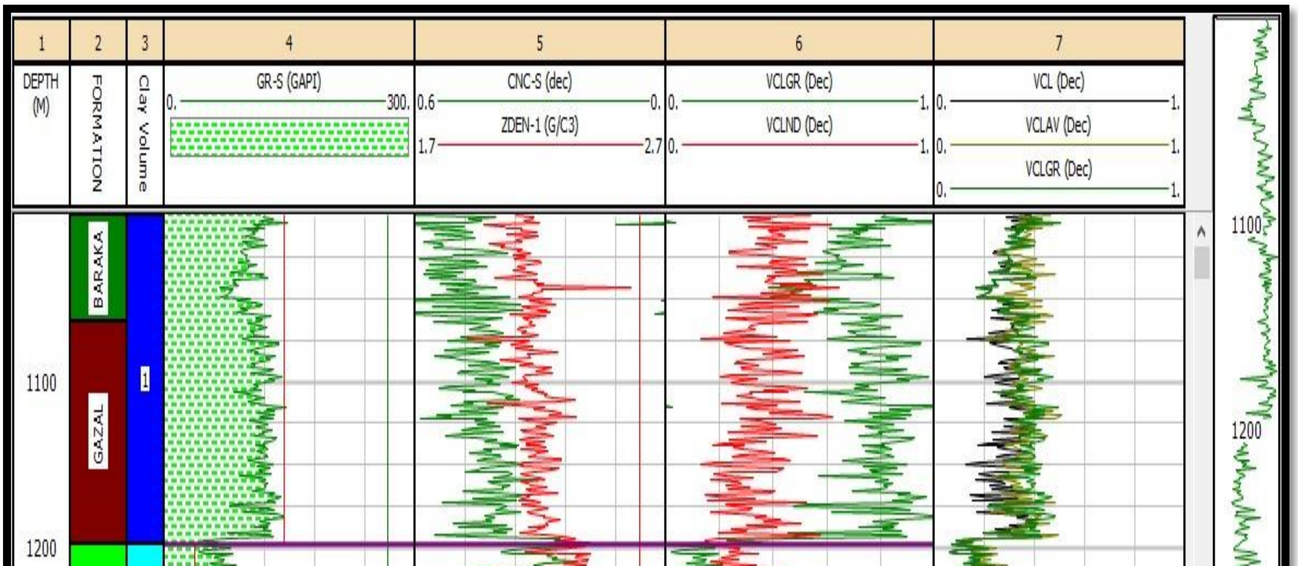


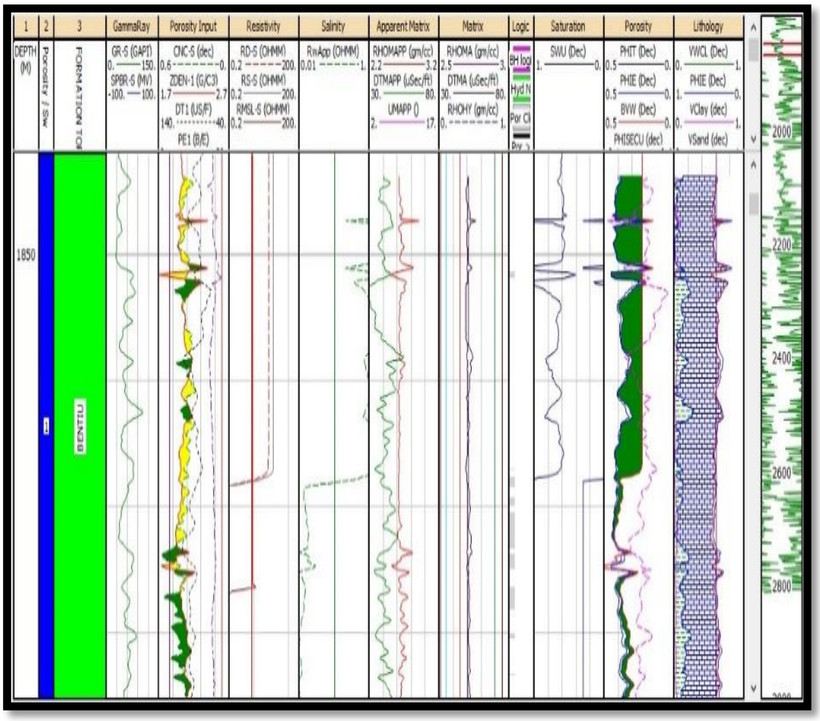
Fig (4.1) Petrophysics interpretation

Calculation Vcl in top of Bantiu formation by GR log and D-N log to identify cap seal propratis , see fig

In this log expline medium GR reding and laimeston lithology in Bantiu formation

From this logs faunded Bantiu formation is a good seal .

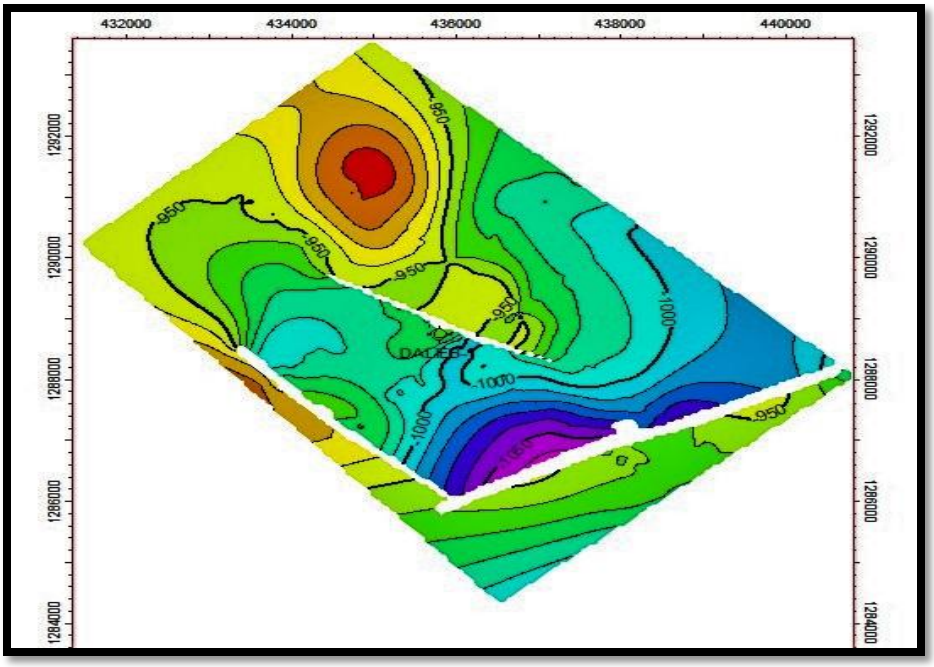
This log explain that Bantiu formation is a good seal because it has high shale volume in top of Bantiu formation. . The sandstones form 58.9% of this formation; the claystones form 41.1% of this formation.



Fig(4.2) In this log expline medium GR reading and laimeston lithology in Bantiu formation , The sandstones form 58.9% of this formation; the claystones form 41.1% of this formation.

From this logs faunded Bantiu formation is a good seal

4.2.3 structure mapping interpretation :



Fig(4.3) structure mapping interpretation

- Normal fault
- fault block
- controlled by on fault

4.3 ABU GABRA AG2 Oil 1 FORMATION (2152m to 3000m):

4.3.1Final geological report mud logging :

The Abu Gabra AG2 Formation in Dalieb-1 is made up of grey to greenish grey claystones interbedded with very fine to fine grained sandstones and thick thickness dark brown shale.

The claystones form 49.8% of this unit; the sandstones form 37.1% of this unit; the shale form 13.1% of this unit.

a) CLAYSTONE:

gray, occasionally greenish grey, trace dark grey, moderately hard to hard, subblocky to blocky, silty in part.

b) **SANDSTONE**:

light grey, trace translucent to transparent, moderately consolidated, very fine to fine grained, occasionally medium grained, trace coarse grained, rounded, occasionally subrounded, trace subangular, well to moderately sorted, quartz, occasionally argillaceous matrix, trace calcareous cement, trace to occasionally kaolinitic cement, poor to fair porosity.

c) **SHALE**:

dark brown, occasionally dark grey, trace dark yellow, moderately hard to hard, occasionally firm, flaky, occasionally subblocky. There were no fluorescent shows observed in this unit.

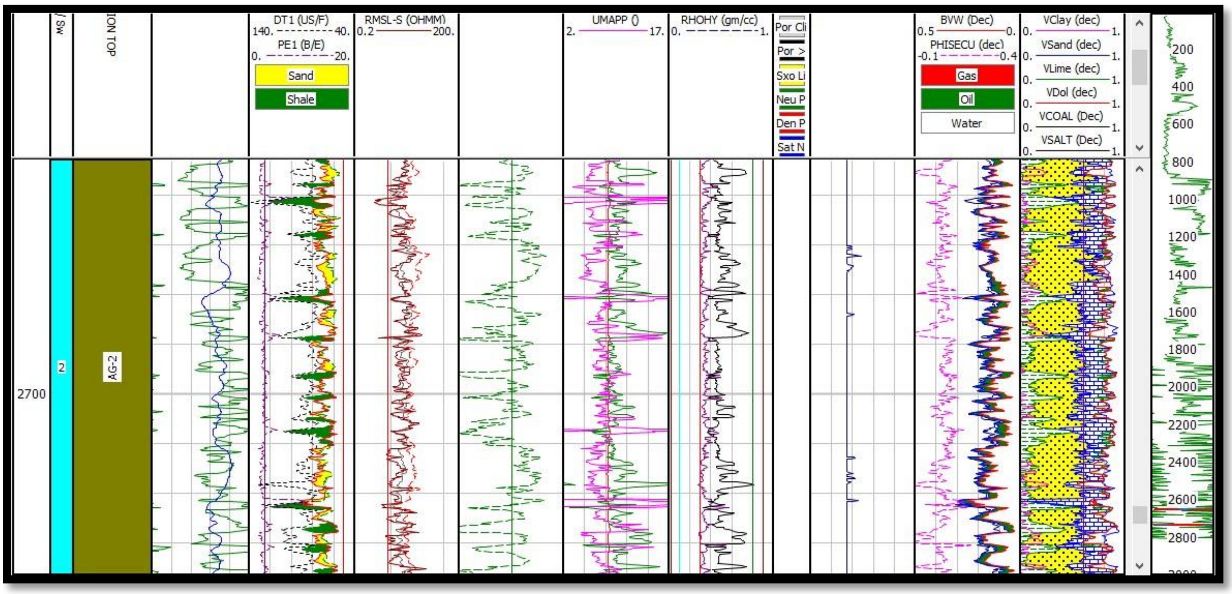
4.3.2Petrophysics interpretation :

Calculate porosity , water saturation and clay voluome due to the possibility of the presence of fluids in AG2 formation.

From this log studies the possibility of accumulation fluid in AG2 fig(4.3) :

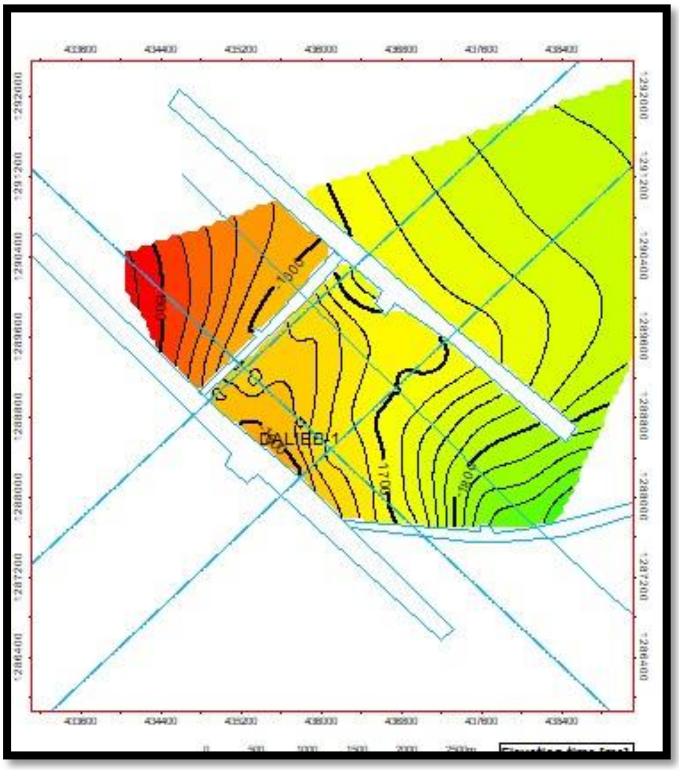
- GR log indecat to sand formation.
- Porosity calculation indecat flueid contant.
- High SP log is indecat of fresh water contant.

The claystones form 49.8% of this unit; the sandstones form 37.1% of this unit; the shale form 13.1% of this unit.



Fig(4.4)AG-2 formation is a good reservoir proprets

4.3.3structure mapping interpretation :



Fig(4.5) structure mapping interpretation

- Normal fault
- Trap – door
- Fully control by faults

Chapter (5)

Conclusion & Recommendation

5.1 From petrophysics reevaluation:

Bantiu formation have good porosity and sand zone it is permeable that mean this formation is a good reservoir and it have high clay volume in top surface, the thickness of this top seal is 140 m ,that make this top a good top seal structure.

AG2 is a good reservoir structure, it have agood porosity and it is permeable. This formation is productive formation and it has interceded shell.

5.2 From structure reinterpretation :

Structure exist and it is fault nose in Bantiu formation.

Top seal exist in Bantiu formation by high clay volume in surface.

This problem may be happened by many reasons like;

- Seal structure isolate the hydrocarbon from reservoir.
- Drilling the well away from reservoir.
- Exist of lateral fault.
- Time trap.

5.3 Recommendation:

One of important observation in this study is there are no shows in formations that mean the hydrocarbon is not arrived to Bantiu and AG2 formations .so we need study of oil migration bath (Basin modelling) and Fault seal analysis.

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