2D SEISMIC REFLECTION DATA INTERPRETATION, PETROPHYSICAL ANALYSIS AND FACIES ANALYSIS OF SANJHORO AREA SANGHAR DISTRICT (SINDH, PAKISTAN)

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CERTIFICATE

It is certified that Mr. Bilal Ahmed S/O Abdul Salam carried out the work is in this dissertation under my supervision and accepted in its present form by the Department of Earth Sciences, Quaid-i-Azam University Islamabad as satisfying the requirement for the award of M.Sc. degree in Geophysics.

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بسم الله الرحمن الرحيم

DEDICATION

I would like to dedicate this thesis work to my sweet parents, whose love, encouragement, guidance and prays make me able to achieve such success and honor.

ACKNOWLEDGMENT

In the name of **Allah** the most merciful and most beneficent. All praises to Him who is Almighty, The One, The Everlasting, Who begets none, is be gotten, by no one, and there is none His equal. Alhamdulillah. I bear witness that Holy Prophet **Muhammad (PBUH)** is the last messenger, whose life is perfect model for the whole mankind till the Day of Judgment. . I am thankful to Allah for the strengths and His blessing in completing this thesis.

I am nothing without your help. Please keep me always in prostration before you and let me not leave before anyone except you.

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Besides my supervisor, I am thankful to my respectable friend for their cooperation and guidance during this research work.I would like to express my appreciation to all of my friends especially Sadiq Jalal, Nasim Ullah and Hamza Rehman for their moral support during my study.

I am extremely thankful to all of my teachers for their endless love, prayers and encouragement and my special appreciation to those who indirectly contributed in this research.

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ABSTRACT

The present study relates to integrated seismic and rock physics analysis of Sinjhoro with special techniques. The area is part of southern Indus basin. The work is carried out on 3 seismic lines along with petrophysical logs of Chak 66-01, using Kingdom software .

The integrated study involves, structural interpretation of seismic data , time to depth conversion , synthetic seismogram , petrophysics ,facies analysis and well correlation .

The seismic section shows Horst and graben structure bounded by normal faults. The horizons were identified using formation tops from wells and their depth were confirmed through correlation with synthetic seismogram generated from sonic and bulk density logs. Time, depth and horizon contour maps of the horizons of interest have been generated to understand the spatial geometry of the structures and polygon were formed, and high concentration of shale clearly shows that there is only a thin reservoir present

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CHAPTER#01

INTRODUCTION

CHAPTER#01

INTRODUCTION

1.1 Introduction to Area:

The given dissertation is to interpret the seismic section along the seismic lines 20017-SNJ-03, 20017-SNJ-04 and 20017-SNJ-01 located in Sindh province area. It is oriented in SW-NE direction. My objective is to interpret the seismic lines of Sinjhoro which is town in Sanghar district, Sindh (Pakistan) about 22.5 km NORT-WEST from Sanghar city, along Sanghar-shah dad purr road. Sinjhoro is part of lower Indus basin. It is extensional regime and normal faults are present there.

The location of area is (figure 1.1) given below.

• **Latitude**	**26° 00' 00N to 26°15' 00 N**
• **Longitude**	**68° 35' 00E to 69° 05 60 E**

Fig. 1.1: Location of the study Area

1.2 _Base map:

A base map (figure 1.2) is the map on which primary data and interpretations can be plotted A base map typically includes locations of concession boundaries, wells, seismic survey points with geographic reference such as latitude and longitude. geophysicist typically use shot points maps, which show the orientation of seismic lines and the specific points at which seismic dara were required , to display interpretation of seismic data.

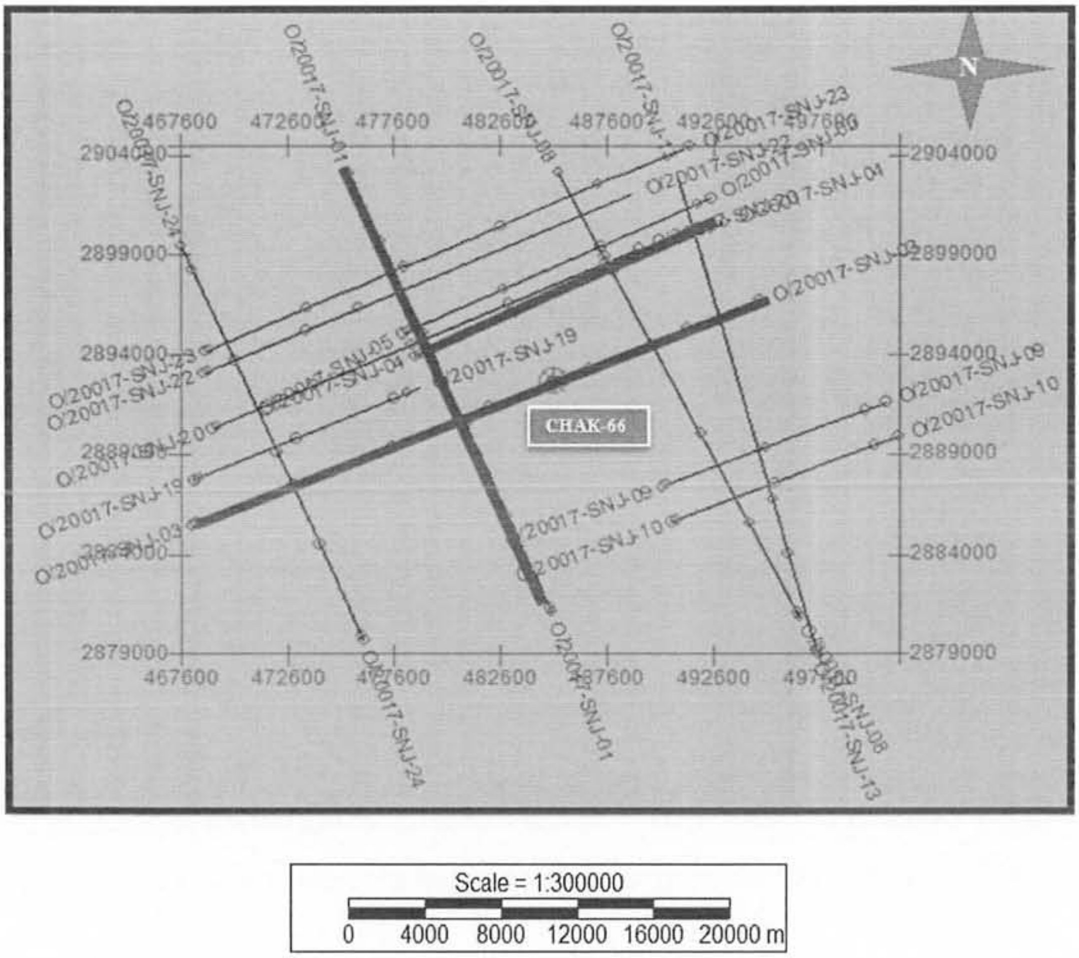


Fig. 1.2: Base map of the study Area

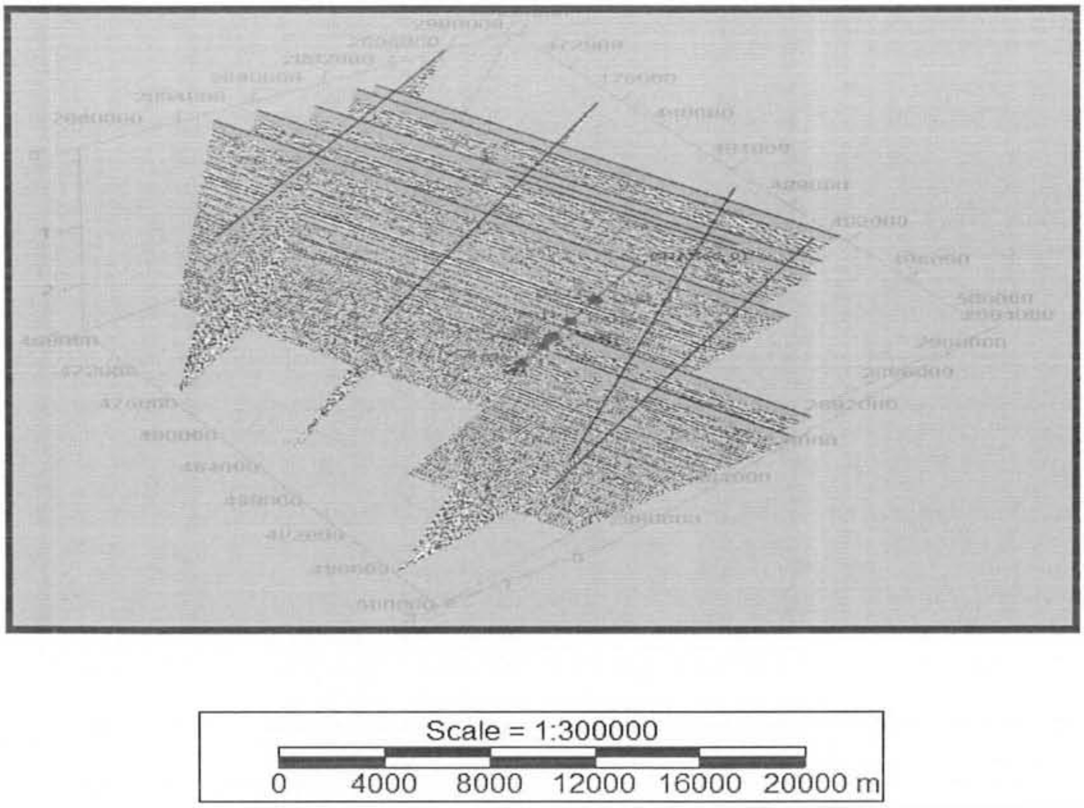


Fig. 1.3: 3D Base map of the study Area

1.3 Introduction_to_lines:

Data was recorded and processed by OGDCL. In dissertation , used the migrated stacked seismic data. The line are 20017-SNJ-03, 20017-SNJ-04 and 20017-SNJ-01

Lines orientation:

Lines	Nature
20017-SNJ-03	Dip line
20017-SNJ-01	Strike line
20017-SNJ-04	Dip line

Table 1.1: nature and seismic lines used for base map

1.4 Objectives:

- To know the procedure / technique involves in acquisition and
- Understanding the processing phenomenon in order to ass's quality of Data.
- Identification and making of reflectors.
- Velocity analysis as a parameter.
- Preparation of time section

CHAPTER#2

GENERAL GEOLOGY

CHAPTER#2

GENERAL GEOLOGY

2.1 Geological History:-

The planet EARTH came into being about 4.6 billion years ago, up to the JURAISIC age there was only one land mass on the earth which was called Pangaea, this land mass started breaking about 200 million years ago and was divided into two parts, the northern part was called laurasia southern part was called Gondwana land. This breakage was initiated by two rifts, one in the northern part, between North America and Africa; it gave to the birth North Atlantic Ocean. Second rift was in the southern part, South America and Africa which gave the birth to the South Atlantic Ocean. Now due the rift that was produced between south America and Africa, a Y shaped crack was produced in the southern part of gondwana land due to which India was separated from the gondwana land, it was done about 130 million years ago. (Tarbuck et al, 2000).

Now there was transform fault, CHAGOS MAURITIUS FAULT and other was along NINTY EAST RIDGE, also ridge was present south of the SRILANKA, this ridge was spreading in such a way that it pushed India north ward, India started its north ward journey. Between 130 and 80 million years, it moved at 3 to 5 cm/year, between 80 and 55, its speed was increased to average speed of 16 cm/year, during time it's varied from 15 to 25 cm/year. Due to this movement, intra oceanic Subduction was occurred, the evidence of this Subduction is present in the form island arcs which include KOHISTAN, LADDAKH, NURISTAN AND KANDHAR ISLAND ARCS.(Kazmi & Jan, 1997).

At this stage India's movement was slowed by its collision with Kohistan and laddakh island arcs; it was done about 55 to 50 million years ago. The most important feature of this collision is the upheaval of the GREAT HIMALAYAS.

The Himalayas are divided in the following sequences.

Laddakh / Tibet Block

Indus – tsangpo suture zone

Tethyan Himalayas

Main Mantle Thrust

High Himalayas

Main central thrust (MCT)

Lesser Himalayas

Main Boundary Thrust (MBT)

Sub Himalayas

Himalayan Frontal Fault (HFF)

Himalayan Fore deep

2.2 Tectonics zone of Pakistan:

On the basis of plate tectonic features, geological structure, organic history (age and nature of deformation, magmatic and metamorphism) and lithofacies, Pakistan may be divided into the following broad tectonic zones;

- **Indus platform and fore deep.**
- **East Baluchistan folds and thrust belt.**
- **Northwest Himalayan fold and thrust belt.**
- **Kohistan-laddakh magmatic arc.**
- **Karakoram block.**
- **Kakar khorasan flysch basin and makran accretionary zone.**
- **Chagai magmatic arc.**
- **Pakistan offshore.**

Within these broad tectonic zones these are subtle differences in tectonic and change in structure style to merit further subdivision into smaller subdivision. Here we are not concern about those; we are going to discuss the relevant that is the Indus platform and fore deep which is our area of interest as from all above mentioned tectonic zones our seismic line belongs to this area.

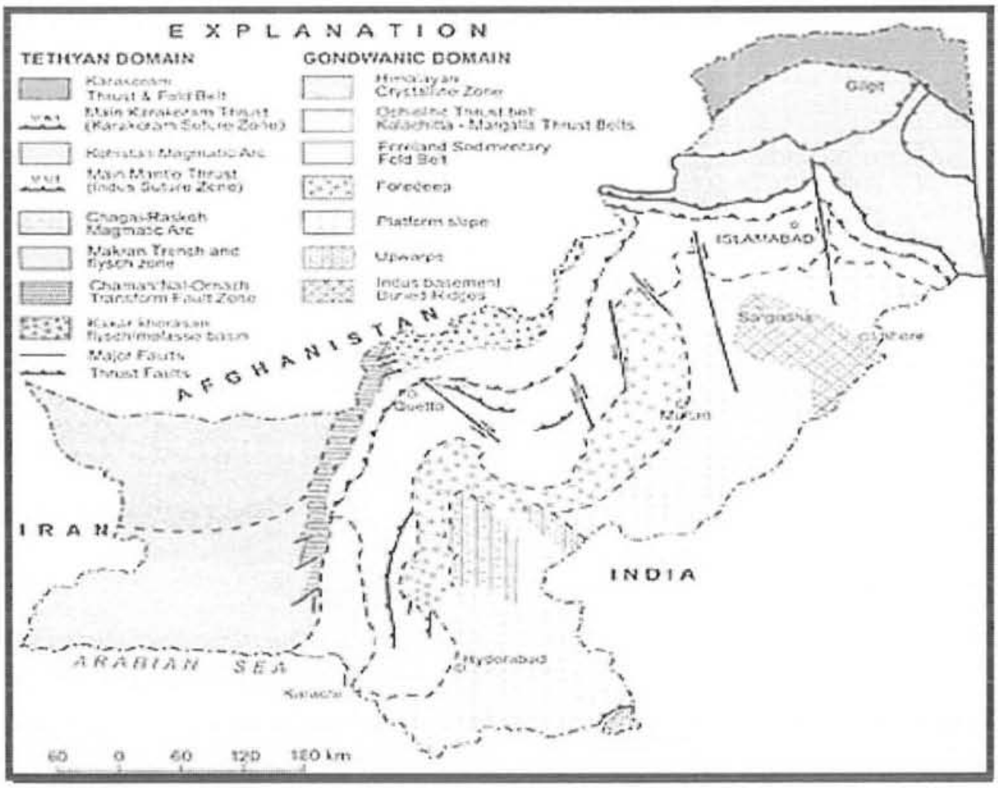


Fig2.1: Tectonic Map of Pakista(Ghazanfar,1993)

2.3Basins of Pakistan:

- Indus basin
- Pashin basin
- Baluchistan basin

2.4 Indus basin:

The Indus basin belongs to the class of extra continental trough down warp basins. It is the largest and so far Only producing sedimentary basin of Pakistan. The basin is oriented in NE - SW direction Basement exposed at two places, one in NE (Sargodha high) and second in SE corner (Nagar parker high) The convergence between Indian and Eurasian plate has resulted in partitioning of the basin into three parts. Upper, middle and lower called as northern, central

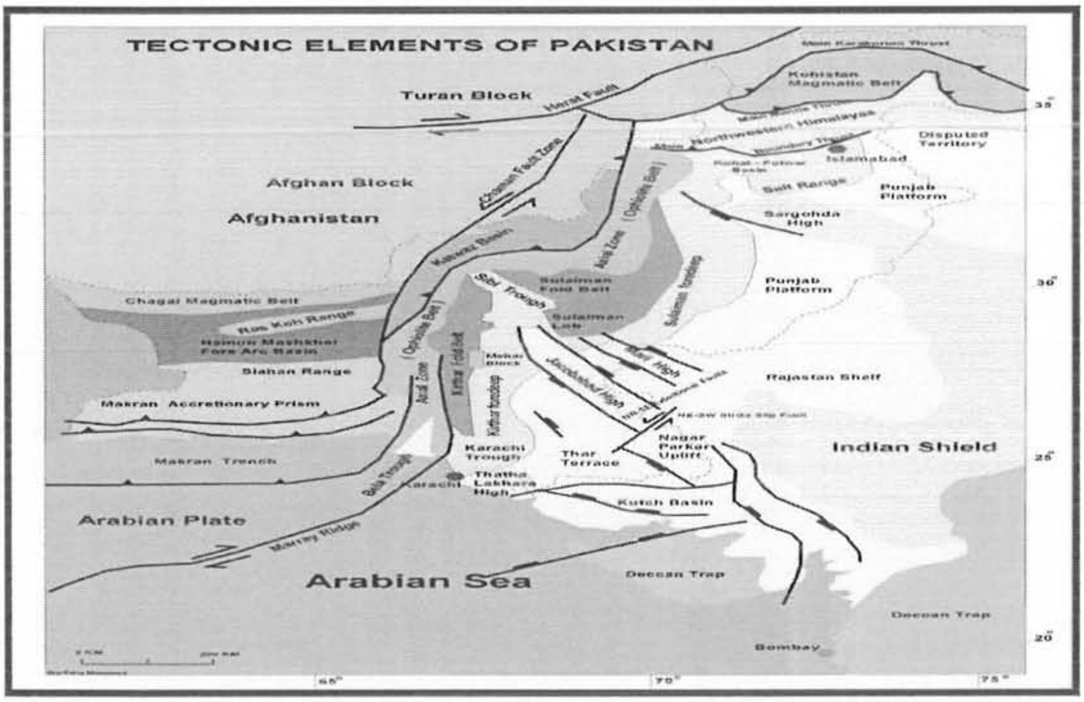


Fig.2.2:Map of Pakistan showing different bains and area of intrest(Kemal 1992)

2.4.1 Division of Indus basin:-

Division of Indus basin:

- **Upper Indus basin**
- **Central Indus basin**
- **Lower Indus basin**

2.5 Boundaries of upper Indus basin:

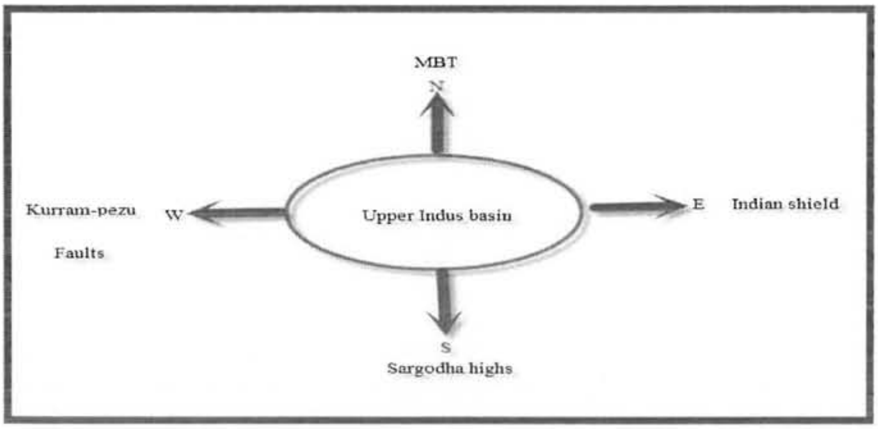


Fig 2.3 shows the boundaries of upper Indus basin

2.6 Boundaries of central Indus basin:

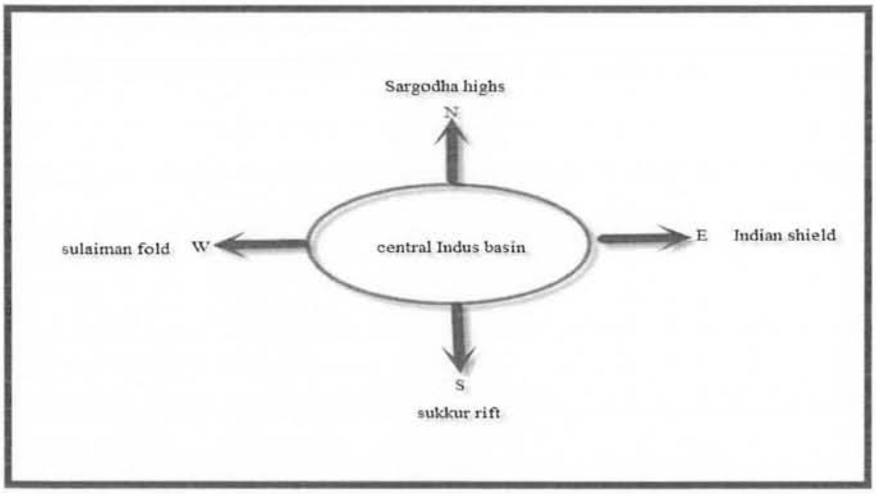


Fig 2.4 shows the boundries of central Indus basin

2.7 Boundaries of lower Indus basin:

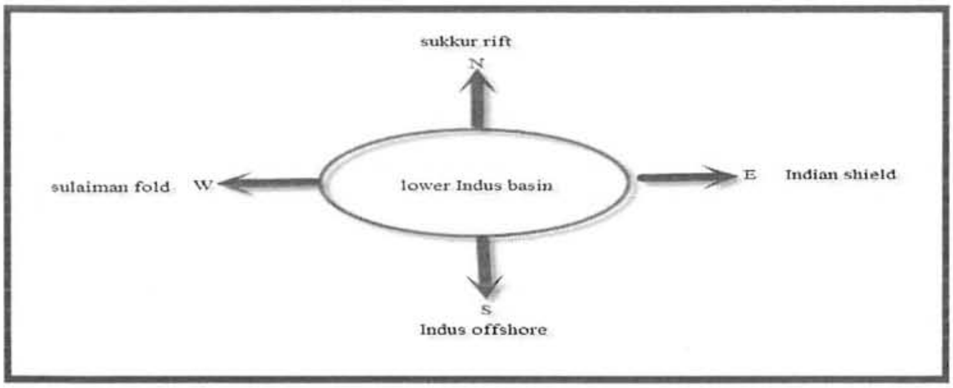


Fig 2.5 shows the boundaries of lower Indus basin

2.8 Generalized geology of lower Indus basin

2.8.1 Basin Classification:

This basin is located just south of sukkur rift, a divided between central and southern Indus basin (fig. 2.1). It comprises the following units:

1. Thar platform
2. Karachi trough
3. Kirthar fore deep
4. Kirthar fold belt
5. Offshore Indus

The platform and trough extend into the offshore Indus. The southern Indus basin is bounded by the Indian shield to the east and the marginal zone of Indian plate to the west. It is southward extension is confined by offshore muray ridge- oven fracture plate boundary (fig 2.1). The oldest rocks encountered in the area are the Triassic age.

Central and southern Indus basins were undivided until khairpur- Jacobabad high became a prominent positive feature. This is indicated by homogeneous lithologies of Chilton limestone (Jurassic) and sember formation (lower cretaceous) across the high. Sand facies of guro formation (lower middle cretaceous) are also extending up to kandhkot and Giandari area. This is further substantiated by khairpur and jhatpat wells located on high. In khairpur -2 well, significant amount of lower cretaceous and Paleocene missing while in jhat pat -4, the whole cretaceous and

Paleocene are absent with Eocene directly overlying Chilton limestone. Paleocene facies south of the high are quite different from those in north and are dominant by clastic sediments derived from the positive areas (khair-jacobabad high and nabisar arc).

2.8.2 Stratigraphy of lower Indus basin:

Stratigraphy column of lower Indus basin is shown in fig 2.6. This column shows distribution, age and lithologies of the area

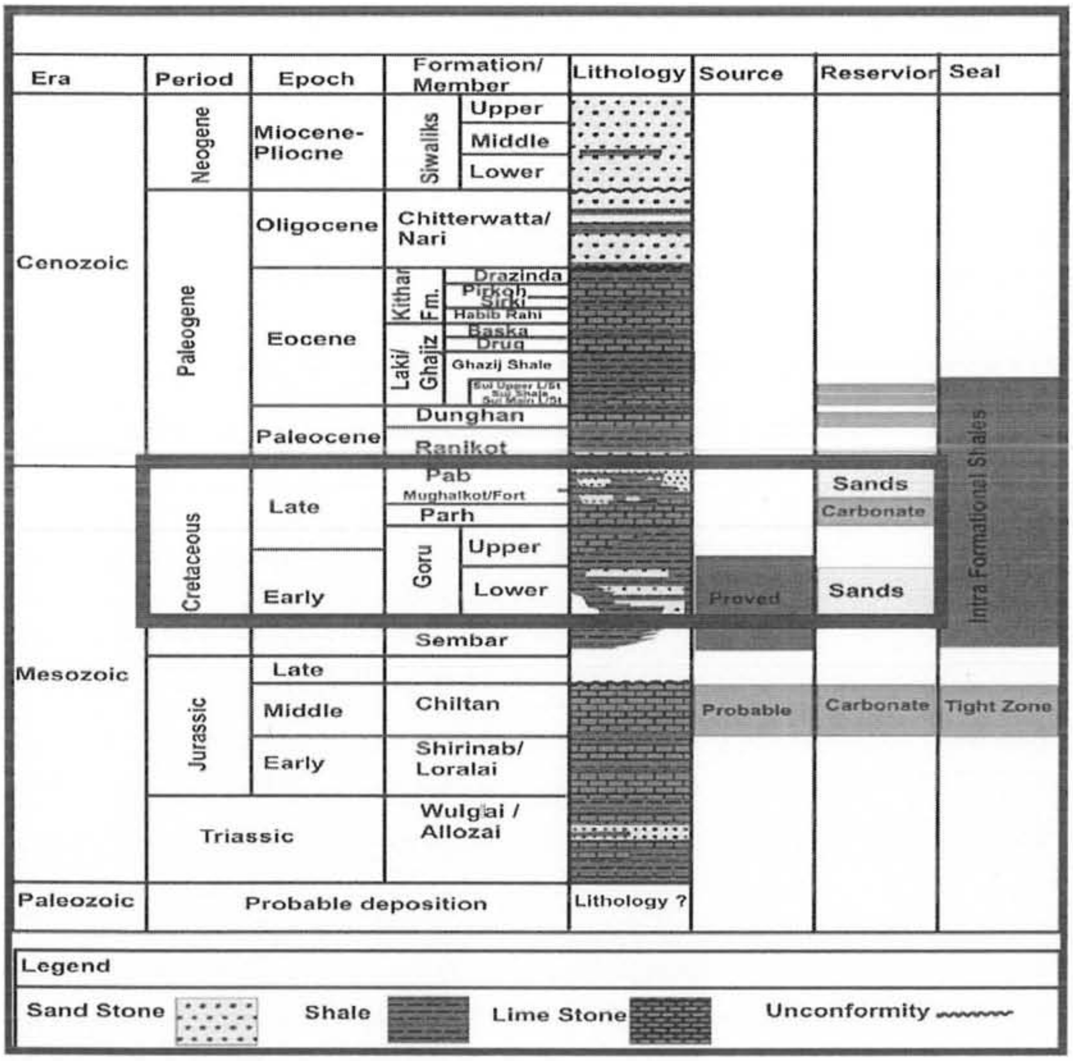


Fig 2.6 generalized stratigraphy of lower Indus basin(www.gsp.pk.com)

Southern Indus basin is characterized by passive roof complex-type structure and passive back thrust along the Kirthar fold belt, a passive roof thrust forming a frontal culmination wall along the margin of fold belt and the Kirthar depression and out of syncline intermolasses detachment in the Kirthar depression sequence.

The Kirthar and Karachi depression contain several large anticlines and dome sandstone of these contain small gas field e.g. sari, hundi, mazarani, and Kirthar. But in the eastern part of it there are several faults and tilted the blocks of Mesozoic rocks which form structural traps containing small oil and gas field. On the northern sides of its there is sukkar rift zone bearing large anticlimax structures and contains the kandhkot and Mari gas fields. The main reservoir rocks in Sindh monocline are cretaceous lower guru sandstone. The generalized Stratigraphy of lower Indus is given by figure 2.6.

2.9 General Geology of Sinjhoro Area:

As project area located in Sanghar district which is part of southern Indus basin. So we can regionally define geology of Sanjhoro area. The southern Indus basin is identified as an extensional basin characterized by tectonic up warping on the western margin of the indo Pakistan subcontinent. Several hypotheses have so far been proposed to explain the origin of these crustal features, but basement warps remain puzzling. Thar platform gently sloping monocline analogous to Punjab platform controlled by the basement topography; the sedimentary wedge thins towards the Indian shield whose surface expressions are present in the form of nagar parker high. It differs from the Punjab platform in that it depicts the buried structures formed due to extension tectonics resulting from the latest counter clock wise movement of the Indian plate. It is bounded in the east by the Indian shield merges into Kirthar and Karachi trough in the west and is bounded in the north by Mari-Bugti inner folded zone.

The stratigraphic structure cross section constructed through Thar platform, Karachi trough and offshore Indus clearly shows the stratigraphic and structural variation across the two sub basins. The platform marks very good development of early / middle cretaceous guru sand which are reservoir for oil and gas. (Kadri, 1995).

2.10 Boundaries of Sinjhoro Area:

Sinjhoro area is bounded in the east by Indian shield merges into Kirthar and Karachi trough and in the north by Mari bughti inner folded zone. The Indus offshore platform in the south.

2.11 Physical features / Topography:

The study area is part of lower Indus plain formed by the alluvial deposits of the Indus River. Being a vast alluvial plain its land is very uniform in character and is not diversified by hills or rivers. The southern part of the district is close to the delta of the river Indus and the land surface is, therefore, relatively low as compared to the north half, the general elevation of the district is about 50 meters above sea level. Clay and sand are principal ingredients of the soil and one of the two factors by which the composition of the various soils is differentiated is the extent to which the clay or the sand predominates. The other criterion for the character of a soil is the presence or absence of natural salt.

2.12 Hydrocarbon Potential of the Project Area:

The oil production has been established in the lower guru sandstones, in layers l, ll and lll of cretaceous age. Progressive rifting of the indo-Madagascar plate commenced, as stretch troughs. Early in the cretaceous period, during the initial phase of the evolution of the rift system the sember formation with significant organic content was deposited under restricted circulation. The formation, along with the basal shale of the lower guru formation, represents the major source of hydrocarbon in the lower Indus basin. With the evolution of the rift system into a more mature half graben stage, the extensional tectonics resulted in tilted fault blocks over the Thar slopes. The lithosphere during the evolution of the rift system underwent readjustment causing subsidence and uplifts.

Coupled with the worldwide eustatic pulses, the changes in sea level influenced depositional environments, resulting in sequence of delta related sand bodies and marine shelf shale deposits. The tectono-eustatic oscillation also creates a number of minor disconformities and marine transgressions. During mid-cenozonian in one such marine submergence,'' Sinjhoro shale's" were deposited under more open marine environments and characterized by greater carbonate content (marls and thin limestone bands).After subsequent uplift, many reservoirs in the region.

Following a prominent depositional break, turonian marine transgression created environments for pelagic sedimentation of the upper guru formation. These plastic marls and shale's provide the capping mechanism with a thickness approaching 1,000 meters in the project area. Tilted fault blocks and horst draped by upper guru ductile lithologies; possibly, along the up dip truncation of post-Sinjhoro shale sand bodies by Tournian disconformities form the prevalent play types. (ECL, 1988)

2.13 Structures of the project area:

The structure is the result of a normal faulting on the west dipping Indus plain. The fault planes act as way for the migrating fluids from underlying shaly source sequence. Trends of faults and contour are mapped utilizing all well and seismic control for the field.

Seismic interpretation constitutes the basis for the structural interpretation as no surface outcrops are found over the field. The lower guru hydrocarbon accumulation in project area is bounded on the east and on the west by regional extension faults dipping to the east and trending NW-SE.

2.14 Source Rocks in the Study Area:

The lower cretaceous shale of sember formation are proven source for oil and gas discovered in the lower Indus basin because of its organic richness in oil-prone kerogen type and thermal maturity. The lower part of the guru formation is moderately rich in organic shale having fair to good genetic potential. This shale was geochemically analyzed at shadapur well. Studies based on virginities reflectance infer that the kerogen is virginities dominated and immature up to a depth of 2977 m in lower guru formation. Where amorphous organic matter rich oil prone kerogen become dominant and can be regarded as " potential source rock" paralyses result of shahdadpur well indicate that in lower guru formation from 2925 m to bottom depth, there is a zone of maturity transition from oil and wet gas generation to dry gas generation.

2.14.1 Reservoirs Rocks:

Basal sands lower guru (cretaceous) formation is the primary objective in this area. These sands are proven in this area. Average porosities for these sands are around 11% in the prospect area.

2.14.2 Cap Rocks:

A thick Stratigraphy sequence of shale and marl of upper guru formation serve as cap rock for underlying lower guru sand reservoir. Shale of lower guru formation also the same properties.

2.15 Stratigraphy of the Sinjhoro Area:

Sinjhoro block is located in the Thar platform of southern Indus basin. The Sinjhoro area is characterized by a series of horst and grabens structure present almost below the base. The extensional tectonics during the cretaceous time created the tilted faults blocks over a wide area of eastern lower Indus sub basin. The sedimentary section of lower Indus basin in south eastern Pakistan consists of mainly of Permian to Mesozoic sediments overlying a strong angular unconformity of presumably late Paleozoic age. The whole area under investigation is overlain by alluvium as such no out crops are present at the surface which can yield a direct evidence of the stratigraphic succession as in fig 2.6. This part represents progradational Mesozoic sequence on westward inclined gentle slope. Every prograding time unit represents lateral facies variations from continental to shallow marine in the east to west. In Thar slope areas of all Mesozoic sediments are regionally plunging to the west and are truncated unconformably by volcanic (basalts of khadro formation) and sediments of Paleocene age. Permian Triassic and lower Jurassic sediments in the Sindh area consists of inter - bedded sandstone, siltstone and shale of continental to shallow marine origin.

The generalized cretaceous Stratigraphy of study area is shown in fig 2.6. The cretaceous shale of sember shale formation and basal sands of lower guru (cretaceous) formation are proven source and reservoir respectively in Sinjhoro area, therefore more deliberation is on cretaceous Stratigraphy.

2.16 Major Formation of Area (Sinjhoro)

Following are the major formation of Sinjhoro area:

2.16.1 Sember formation:

This name was introduced by Williams, after sember pass in the Mari hills, to include lower part of the "belemnite beds". It consists of black silty shale with interbreeds of black siltstone & nodular rusty weathering, argillaceous limestone beds or concretion. Glauconitic is commonly present. Pyretic & phosphate nodules & sandy shale are developed locally in basal part. Thickness is 133 m to 262 m. its upper contact with Chillan limestone & shirinab formation is disco formable while upper contact is generally gradational with guru formation. The formation is reported to contain foraminifers, but most common fossils are belemnites. The age of formation is late Jurassic. The sember formation is correlated with chinchilla formation.

2.16.2 Goru formation:

The name goru formation was introduced by Williams for rocks included by Oldham in the upper parts of his "belemnites beds". Goru formation consists of interceded limestone, shale and siltstone. The limestone is fine grained, thin bedded, light to medium gray. Limestone is dominant in the lower and upper part of the formation. It is 536 m thick in type locality, but decreases to 60 m. the lower contact with the sember formation is conformable, though locally an unconformity has been reported, the formation contains, foraminifers and belemnites, the age of formation is assessed mainly as early cretaceous. It may be correlated with Lumshiwal formation of the kohat-Potwar-province.

It is divided in two parts:-

(a) Lower goru

(b) Upper goru

(a) Lower Goru:

The lower goru is main reservoir rock within the area. The lower goru horizon as a general 5 divisions based on predominant lithologies.

The basal sand unit, lower shale, middle unit (which has a good reservoir potential), upper shale and upper sand.

(b) Upper Goru:

The upper guro sequence of the middle to late cretaceous unconformable overlies the lower goru formation, which consist of mainly marl and calcareous clay stone occasionally with inbreeds of silt and limestone. (Gilbert Killing et al).

2.16.3 Parh limestone:

It is very distinct unit. It is hard, light grey, white, cream, thin to medium bedded, argillaceous, occasionally platy to slab limestone. It is widely distributed in lower Indus basin. In the type area the thickness is 268 m but varies from 300 m to 600 m. the formation is rich in foraminifers and is dated as late cretaceous. The formation is correlated with the kawagarh formation of the kohat-Potwar-province.

2.16.4 Ranikot Group:

It is considered to comprise 3 formations, which, in ascending stratigraphic order are,

(a) Khadro formation (cardita beaumonti beds),

(b) Bara formation (lower ranikot)

(c) Lakhra formation (upper ranikot).

(a) Khadro formation:

Cardita beaumonti beds of Branford and later workers were renamed khadro formation by Williams. Both sandstone and limestone are fossiluferous. Top of unit is usually marked by volcanic flow. It is 170 m thick but may vary from 140 m to 180m. This formation consist of formation, the age of formation is regarded as early Paleocene. It may correlated with the lower part of the Rakhshani formation.

(b) Bara formation:

Ahmad and Ghani have proposed the name Bara formation for the "lower ranikot" of vredenburg and lower ranikot of later workers. The formation consists of dominant sand stone with lesser shale and minor volcanic debris. Sandstone is varicolored, fine to coarse-grained, soft and crumbly. Massive looking beds ranging in thickness from few cm to 3m are common. It is calcareous, ferruginous ripple marked and coarse stratified. Both shale and sandstone are carbonaceous. Ferruginous nodules are usually present. The formation is widely distributed in the Kirthar province and axial belt it is 450 m thick at the type locality , 600m at ranikot and 50 m in subsurface. The formation conformably overlies formation and under lies the lakhra formations at places where the overlying lakhra formation is absent; it is unconformable overlain by the laki formation. No fossils have been reported, except for some oysters, reptile's remains and carbonized leaf impression. The formation is correlated with Hangu formation of kohat-Potwar-province.

(c) Lakhra formation

Ahmed and Ghani proposed the name lakhra formation after lakhra, for "upper ranikot" of vredenburg and "upper ranikot" of later workers.

The formation consists of dominant limestone, which is gray with yellowish staining and weathers brown and buff. It is thin to thick bedded, nodular, and a brecciated texture. Some of the fossiliferous beds are coquina like. It is widely distributed in Kirthar-province and the axial belt. It is 242 m thick at the type section, 135 m at the northern flank of the lakhra anticline and 50 m at Bara nai. In the Kirthar province, it is unconformably overlain by the laki formation. Khan, M.H. has recorded presence of rich assemblages of foraminifers, corals, mollusks and echinoids. The formation is correlated with Lockhart and Patala formation of the kohat -pot war-province.

2.16.5 Laki formation:

Laki formation also represent the "sui main limestone" to distinct members are identified in the lower part of formation in parts of Kirthar province. The formation consist mainly of cream colored to gray limestone but marl, calcareous shale, sandstone and lateritic clay may vary up to 600m. the formation is unconformable underlain by the ranikot group and contact is marked by sohnari member. The formation contains rich fossils assemblages including, bivalves, echinoids and algae. These fossils indicate an early Eocene age. The formation is correlated with Karin formation.

CHAPTER#03

SEISMIC METHODS

CHAPTER#03

SEISMIC METHODS

3.1 Introduction To Seismic Method:-

Seismic Methods deal with the use of artificially generated elastic waves to locate hydrocarbon deposits, geothermal reservoirs, groundwater, archaeological sites, and to obtain geological information for engineering. It provides data, when used in conjunction with other geophysical, borehole and geological data, and with concepts of physics and geology, can provide information about the structure and distribution of rock types (Kearey et al., 2002).

3.2 Seismic Exploration Method

There are two main sub-methods in seismic method:

Seismic reflection method

Seismic refraction method

Seismic Reflection Method

This method is based on the study of elastic waves, which are reflected from subsurface interface between two geological layers. These layers differ from each other in densities, velocities and product of densities and velocity is called Acoustic impedance. When a seismic wave strikes the interface of two layers having acoustic impedance contrast, it is reflected back. The seismic reflection is very powerful tool being widely used in oil and gas exploration.

Depth of reflecting interfaces can be estimated from the record time and velocity information that can be obtained either from reflected signal themselves or from surveys in well (Dobrin&Savit, 1988).

Reflection

It is the process by which wave came back into the same medium from which it was generated after falling/striking at the boundary between the two mediums, as shown in the figure 3.1(a).

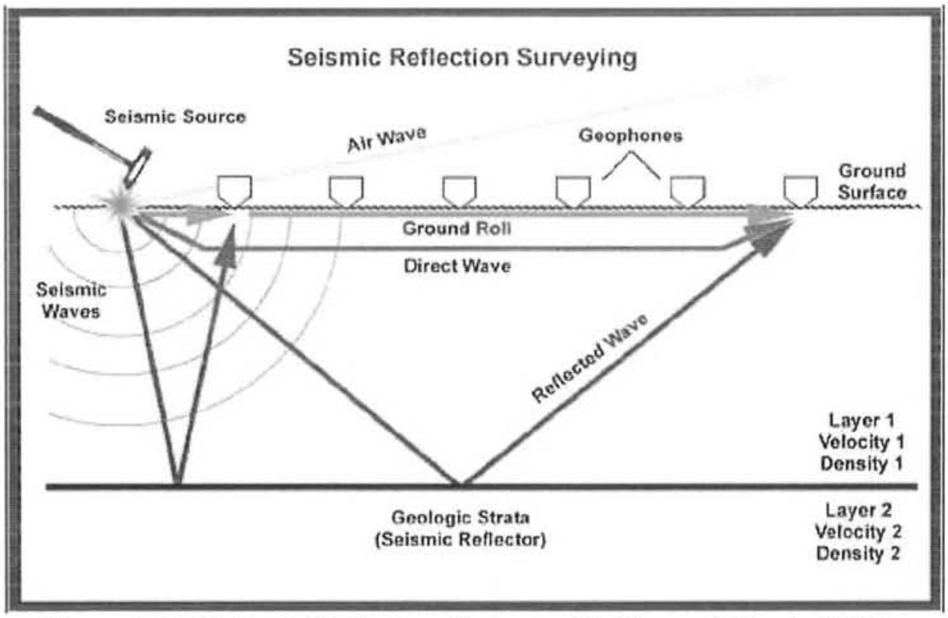


Figure 3.1 (a)Seismic Reflection Geometry (Robinson &Coruh, 1988).

Seismic Refraction Method

The seismic refraction method utilizes seismic energy that returns to the surface after traveling through the ground along refraction ray paths. This method is normally used to locate refractions from separate layers of different seismic velocities (Kearey et al., 1982).

Refraction

A Process in which, a wave moves from one medium to other medium, both having different acoustic impedance, then wave changes its path (that is either moves towards or away from the normal to the interface at the point of intercept) as shown in the figure 3.2.

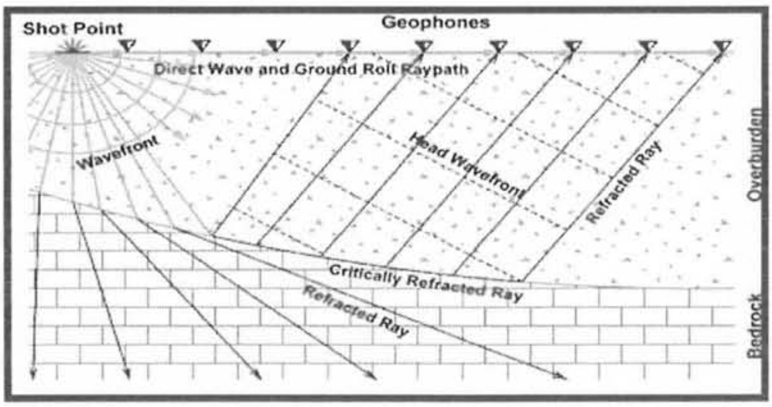


Figure 3.2 (b) Seismic Refraction Geometry (Robinson &Coruh, 1988).

3.3 Steps of Seismic Methods

3.3.1 Seismic Data Acquisition

Data acquisition is the first step of seismic survey. In data acquisition we record earth response caused due to seismic source. Seismic waves record by an instrument known as geophone, in case of marine survey hydrophone is use to record seismic waves. The basic field activity in seismic surveying is the recording of seismic data which may be defined as analog or digital time series that register the amplitude of ground motion as a function of time during the passage of seismic wave train. The Acquisition starts from shot and ends at recording the seismic events through various steps. Different energy sources are used to produce seismic waves and array of geophones are used to detect the resulting motion of earth.

The resulting data, combined with assumptions about the velocity of the waves through the rocks and the density of the rocks, are interpreted to generate maps of the formations. Fundamental purpose of seismic data acquisition is to record the ground motion caused by a known source in a known location. First step in seismic data acquisition is to generate a seismic pulse with a suitable source. Second is to detect and record the seismic waves propagating through ground with a suitable receiver in digital or analogue form. Third is the registration of data on a tape.

The Spread Configuration

For acquisition of data and as well as to have quality of data high certain field operations are adopted. So the first step in this practice is the choice of spread type. The spread is defined as the lay out on the surface of, of the detectors which give recorded output for each source. Spread is made up of equal inter-receiver distance and a defined offset. There is certain basic spreads, which are used in seismic acquisition see figure 3.3(a). These spreads are:

(a) End on spread

(b) Inline offset spread

(c) Split Spread/Centre shooting

(d) Fan shooting

Fan shooting

Along with these basic spreads, another technique called as Fan shooting can also be used. In this technique, geophones are arranged in an arc, fanning out in different directions from the source. Fan shooting is used in Transmission method. Transmission method differs from normal refraction method in the sense that it does not involve critical incidence of waves over the interface. In Transmission method, source and detector are on opposite sides of the investigated interface.

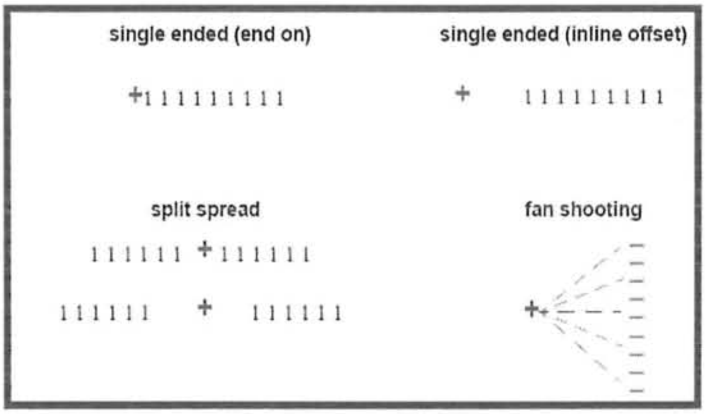


Figure 3.3(a) The basic spreads used in Seismic Acquisition(Khan, 2010)..

Shooting Types

(a) Split Shooting

In this number of channels on both sides of source is same and we have a symmetric spread

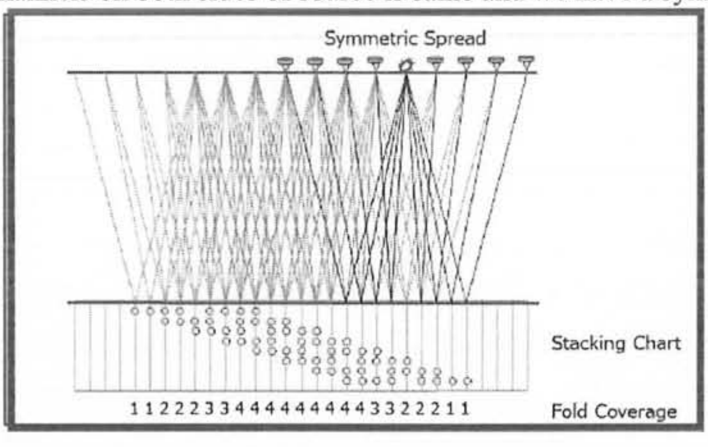


Figure 3.3(b) Geophones Symmetric Spread during Split-Shooting (Khan, 2010).

(b) End on Shooting

In this type of shooting the number of channels on both sides of source is not same and we have a asymmetric spread (see figure 3.3c).

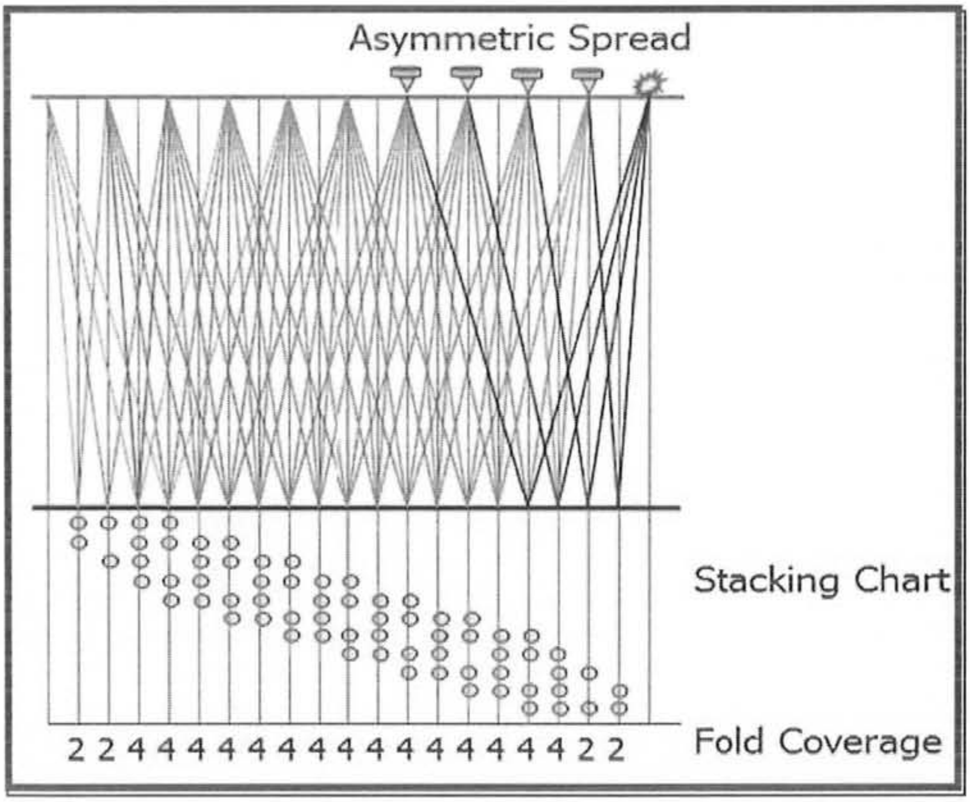


Figure 3.3(c) Geophones asymmetric spread during End-on shooting (Khan, 2010).

3.3.2 Data Processing

Once seismic data has been acquired on field, the second step is the processing data. Data Processing involves sequence of operations, which are carried out according to a pre-defined program to extract useful information from a set of raw data (Al-Sadi, 1980). The main purpose of processing is to convert seismic data recorded in the field into a coherent cross section, indicating significant geological horizons into the earth subsurface, related to hydrocarbon detection and seismic Stratigraphy (Dobrin and Savit, 1988).

3.4 Seismic Data Processing Sequence

The seismic data processing flow chart is given below.

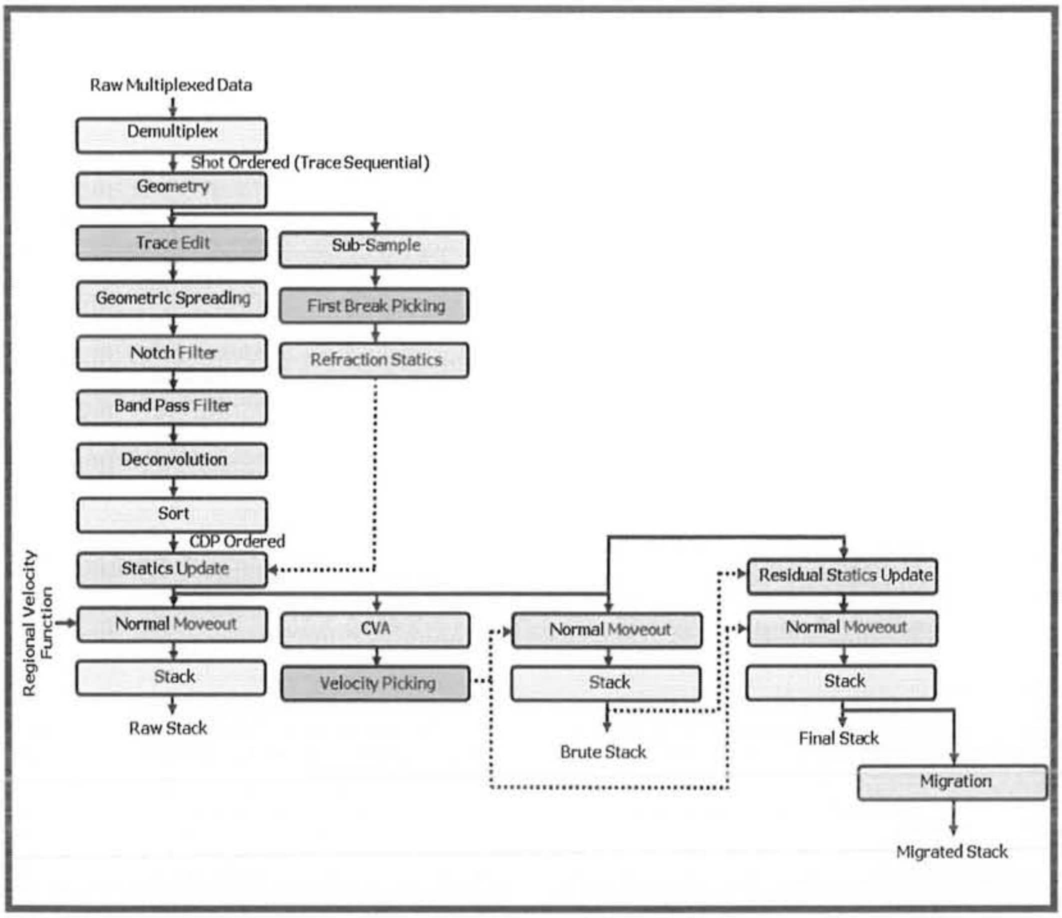


Fig 3.4 shows the data processing work flow(Al-Sadi). 1980).

Demultiplexing

It is the unscrambling of the multiplexed field data to trace sequential form.

Geometric Correction

In order to compensate for the geometric effects, we have to apply certain corrections on the recorded data. These corrections are called as geometric corrections (Dobrin, 1988). These corrections are applied on the traces gathered during trace editing and muting .The geometric corrections are

Static correction

Static correction compensates the effect of weathered layer and elevation effect due to unleveled surface.Static correction is of two types.

(a) Elevation correction

(b) Weathering correction

For land data, elevation corrections are applied at the stage of development of field geometry to reduce the travel times to a common datum level (Yilmaz, 2001).

Dynamic Correction

Dynamic correction compensates the effect of offset of receiver from the source .It is also related to the shape of the subsurface interfaces .It is also of two types.

Normal Move OutCorrection (NMO) Dip Move Out Correction

Normal move out correction is related more to the non-dipping interfaces. On the other hand dip move out correction is related to the dipping reflectors. It accounts for the effect of dip of the subsurface interface along with the effect of offset distance of receivers (Robinson and Crouch, 1988).

Filtering

Filters are used for enhancement of signal. Thus filtering, "Is a process of spectrum modification which involves suppression of certain frequencies".The most common types of filters used are as follows,

(a) Low pass frequency filter

(b) High pass frequency filter

(c) Band Pass frequency filter

(d) Notch filter

Deconvolution

Deconvolution is a filtering process designed to improve resolution and supress multiple reflections (Rehman, 1989).

Data refinement consists of the following two main stages.

Stacking

In the common depth point (CDP) method ,the geometry is such that the sub surface coverage overlaps .when the data are stacked the traces will be summed together to form one stacked trace .this technique is used for data enhancement (Rehman, 1989).

Migration

Migration moves dipping reflectors in to their true subsurface positions ,and collapse diffractions, their by shows detailed sub surface features ,such as fault planes.

The process of shifting the reflection points to the positions that correctly image the reflector and remove diffraction images, so that we may get an accurate picture of underground layers (Robinson &Coruh, 1988).

Types of Migration

There are two important types of migration:

(a) Pre-Stack Migration: This type of migration is applied to data before the stacking process.

(b) Post-Stack Migration: This type of migration is applied to data after the stacking process.

3.5 Data analysis and parameter optimization:-

The following processes are involved in the seismic data analysis.

3.5.1 Velocity analysis:-

Velocity analysis is done to find the velocity that flattens a reflection hyperbola, which returns the best result when stacking is applied. There are different ways to determine the velocity

- (t2-x2)-Analysis
- Constant velocity panels
- Constant velocity stacks
- Constant velocity panels (CVP)

The NMO-correction is applied for a CMP using different constant velocities.

3.5.2 Constant velocity stacks(CVS):-

The data is NMO-corrected. This is carried out for several CMP gathers and the NMO-corrected data is stacked and displayed as a panel for each different stacking velocity. Stacking velocities are picked directly from the constant velocity stack panel by choosing the velocity that yields the best stack response at a selected event. Both methods can be used for quality control and for analysis of noisy data.

3.5.3 Velocity-Spectrum:-

The velocity spectrum is obtained when the stacking results for a range of velocities are plotted in a panel for each velocity side by side on a plane of velocity versus two-way travel-time. This can be plotted as traces or as Iso-amplitudes.

3.6 Seismic recorder:-

Seismic Recorder picks seismic signals (vibrations) from geophone/hydrophone sensors and records them on magnetic media in a digital format. It consists of multiple channels, each connected to a geophone group. It is similar to an audio tape recorder which picks audio signals from microphone and records them on a magnetic tape (cassette). A geophone is a transducer which transforms mechanical energy (seismic vibration) into electrical energy. It consists of a moving coil and a stationary magnet. The movement of the coil due to vibration creates electromagnetic flux proportional to the magnitude of vibration. The block diagram of a digital seismic recorder is given above in Fig. 3.3 followed by description of all main modules .

Types of seismic recorder:-

There are two types of recording systems generally used in seismic surveys.

- Analog recording system
- Digital recording system

3.6.1 Analog Recording System:-

Analog techniques are old techniques which produce continuous graphs. The graphs are obtained either on papers or magnetic tape that represents the variation in amplitude with respect to time, of seismic waves.

3.6.2 Digital Recording System:-

The technique of recording the geophone output at discrete moments is called digital recording because the recording consists of series of digits or numbers. Later these numbers can be plotted and the seismogram prepared by connecting the points. The digital data is recorded on a magnetic tape in the form of binary numbers. Each digit of binary number on the tape is called a byte. If the recording head magnetize this byte then it indicates "1" otherwise it is "0

3.6.3Tape Format:-

Most seismic data is recorded on half-inch-wide magnetic tape in 9-track format, that is, with nine pieces of information in the width of the tape. The recorder has nine recording heads in the half inch of width. The tape is on reels, 8 or 10.5 inches across, containing 1200 or 2400 feet of tape. The reels are thoroughly protected from dirt, in individual plastic holders, which are in turn contained in sealed plastic bags. There is an older system, 7-track type, also half inch. Another old system uses one inch wide type. It is recorded with 21 tracks of information in the inch of width (Coffeen, J.A 1986).

3.7 Digital sampling and aliasing:-

The initial seismic instruments recorded data on a moving paper, the next generation instruments recorded analog seismic data on magnetic tapes. With the advent of computers and digital systems, the seismic data was recorded in digital form in some standard format. Today all processing and Interpretation is performed on digital seismic data, thus it is necessary to Understand the difference between analog and digital data and the sampling theory.

It can be seen that discrete samples of amplitude values are taken after fixed interval of time called sampling interval. Joining these samples the sinusoidal function can be reconstructed, if it is in milliseconds the sampling frequency i.e. the number of samples per second. Now the Nyquist frequency, which is the highest recoverable signal frequency for the given sampling frequency. Thus for a given sampling interval, the recorded signal frequencies must not be greater than Nyquist frequency, otherwise they will appear as low frequencies. This is called Aliasing Effect, caused by coarse sampling (under-sampling), as shown in Fig. 3.5 below.

The high signal frequencies that are greater than the Nyquist frequency appear as low frequencies are called Alias frequencies as shown in Fig.3.5 below. In seismic recording system anti-aliasing filters (**fA**) having a high-cut frequency equal to half of Nyquist Frequency is applied to avoid aliasing effect (Khan, 2010)

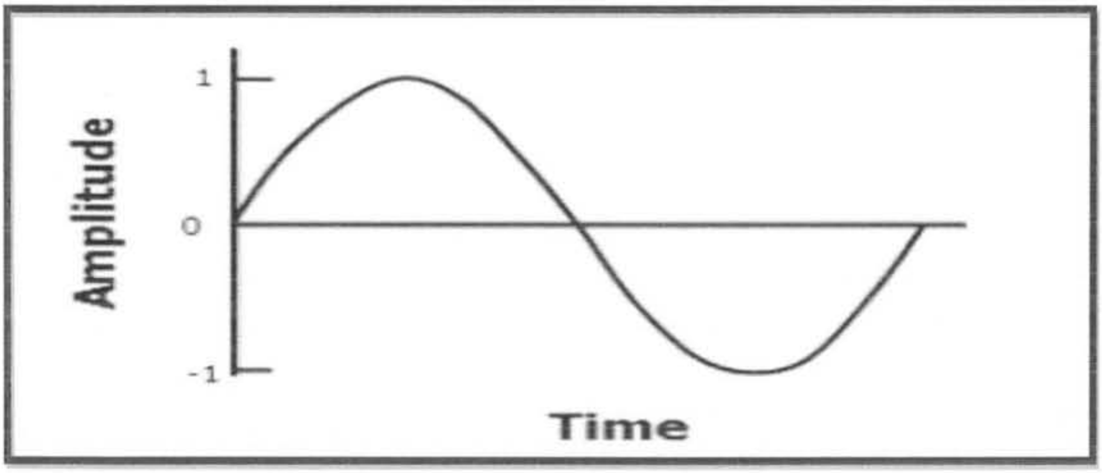
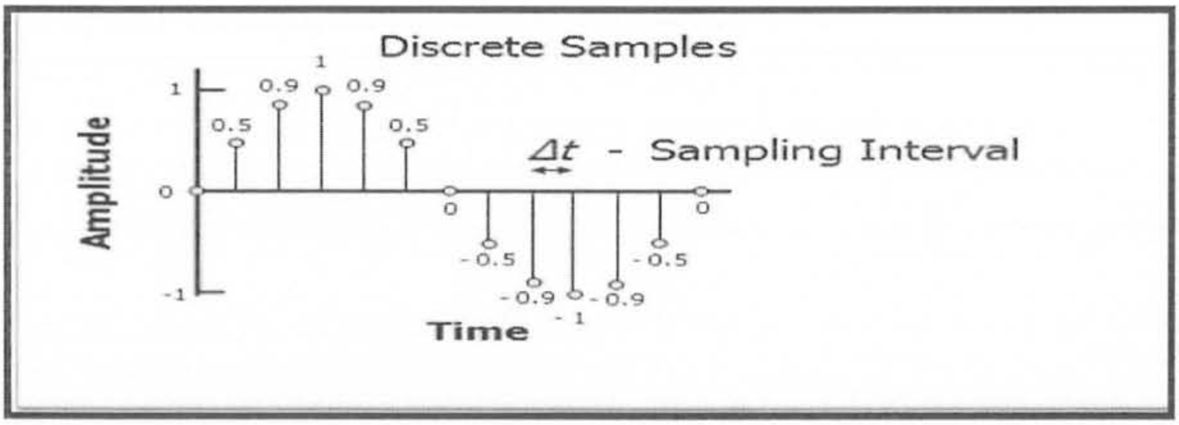


Figure 3.5(a) Showing the Analog Representation of a Sinusoidal Function(*https://en.wikipedia.org)*



Figur 3.5(b) Showing the Digital Representation of Analog Sinusoidal Function(*https://en.wikipedia.org)*

CHAPTER#04
SEISMIC DATA INTERPRETATION

CHAPTER#04

SEISMIC DATA INTERPRETATION

4.1 INTRODUCTION

Interpretaion

Interpretation is a tool to transform the whole seismic information into structural or stratigraphical model of the earth. Since the seismic section is the representative of the geological model of the earth, by interpretation, we try to locate the zone of final anomaly. It is rare that correctness or incorrectness of an interpretation is ascertained, because the actual geology is rarely known in well manner. The test of good interpretation is consistency rather than correctness.

Not only a good interpretation be consistent with all the seismic data, it also important to know all about the area, including gravity and magnetic data, well information, surface geology as well as geologic and physical concept. (Telford et al, 1999)

Conventional seismic interpretation implies picking and tracking laterally consistent seismic reflectors for the purpose of mapping geologic structures, stratigraphy and reservoir architecture. The ultimate goal is to detect hydrocarbon accumulations delineate their extent, and calculate their volumes. Conventional seismic interpretation is an art that requires skill and thorough experience in geology and geophysics.

To meet the challenges of exploring ever increasingly complex targets, there have been tremendous advancements in data acquisition equipment, computer hardware and seismic processing algorithms in the last three decades . The seismic method has thus, evolved into a computationally complex science.

4.2 Discrimination among different formation:

To distinguish different formations by means of seismic reflection is an important question in interpreting seismic reflection data. For this purpose we correlate the data with the well data and geology of the area under observation. The well data provides links between lithologies and seismic reflections. The reflector identification is the next stage by which the actual interpretation starts and it establishes a stratigraphic frame block for the main interpretation.Extracting from seismic data the geological structures, such as folding and faulting are referred to as structural interpretation (Dobrin & Savit 1988). On the other hand, extracting non-structural information from seismic data is called, "Seismic Facies Analysis".

4.3 Main approaches for the interpretation

There are two main approaches for the interpretation of seismic section:

- **Stratigraphic Analysis**
- **Structural Analysis**

4.3.1 Statigraphic Analysis:

Stratigraphic analysis involves the subdivision of seismic sections into sequences of reflections that are interpreted as the seismic expression of genetically related sedimentary sequences. Basic principle in the seismic stratigraphic analysis is that reflections are taken to define chronostratigraphic units because interfaces that produce them are the strata surfaces. Unconformities can be mapped from the divergence pattern of reflections on a seismic section. The presence of unconformable contacts on a seismic section provides important information about the depositional and erosional history of the area and environment existing during the time, when the movement took place. The success
disconformities, Facies changes, pinch-outs and other erosional truncations. (Sheriff, 1999). Some of the parameters used in seismic stratigraphic interpretation are:

4.3.2Structural Analysis:

In structural interpretation main emphasis is on the structural traps in which tectonics play an important role. Tectonic setting usually governs which types of structures are present and how the structural features are correlated with each other's, so tectonics of the area is helpful in determining the structural style of the area and to locate the traps. Structural traps include the faults, anticlines, duplex etc. (Sheriff, 1999).

- Reflection eflection configuration
- continuity
- Reflection Amplitude
- Reflection Frequency
- Internal Velocity
- External Form

Seismic sections can predict the structure that scale up to few tens of kilometers. For large scale interpretation we have to use the grids of seismic lines. Immigrated section is not suitable for structure interpretation, because it creates many problems like synclines becomes narrows and vice versa. Even a migrated section not fully fit for complex area like the area of study.
Some seismic section contains images that can be interpreted without any difficulty. Discontinuous reflectors clearly indicate faults and undulating reflections reveals folded beds.

Most interpretation of structural features is directly marked on seismic time sections (Robinson & Coruh 1988).

4.4 Procedure for Syenthetic seismogram Generation

The Synthetic seismograms for the study area are generated on Kingdom software using the following procedure

- . Load the Las file of the well in the software.
- . Open 1D forward modeling Project and select the well logs.
- . Integrate the sonic log to rescale from depth in meters to two-way travel time in seconds.
- Compute velocity from sonic log for P and S waves.
- . Create a TD chart for the well from the velocity logs.
- . Compute Acoustic impedance log using velocity and density log.
- . Compute the reflection coefficients from the time-scaled velocity log.
- . Compute a first-order Ricker wavelet as a digital filter with two millisecond increments of two-way travel time; using a frequency in Hertz (35 Hz frequency is used in this study)
- . Convolve the reflection coefficient log with the Ricker wavelet to generate the amplitudes of the synthetic seismogram

Synthetic seismogram contains very useful information like Elevation of Kelly bushy (KB), ground level, datum, information like time scale, traces per inch, sample interval. Band pass is filter used range of 10--50 Hz means it allows the waves that are in the frequency range of 10 to 50 Hz and rejects the waves that are below 10 Hz and Above 50 Hz, frequency greater than 60 must not use because the result saturates at this value. Synthetic seismogram has the information of phase data used and length of wavelet generated the depth scale, reflection coefficient log, sonic log, density logs and the length of source wavelet generated and depth

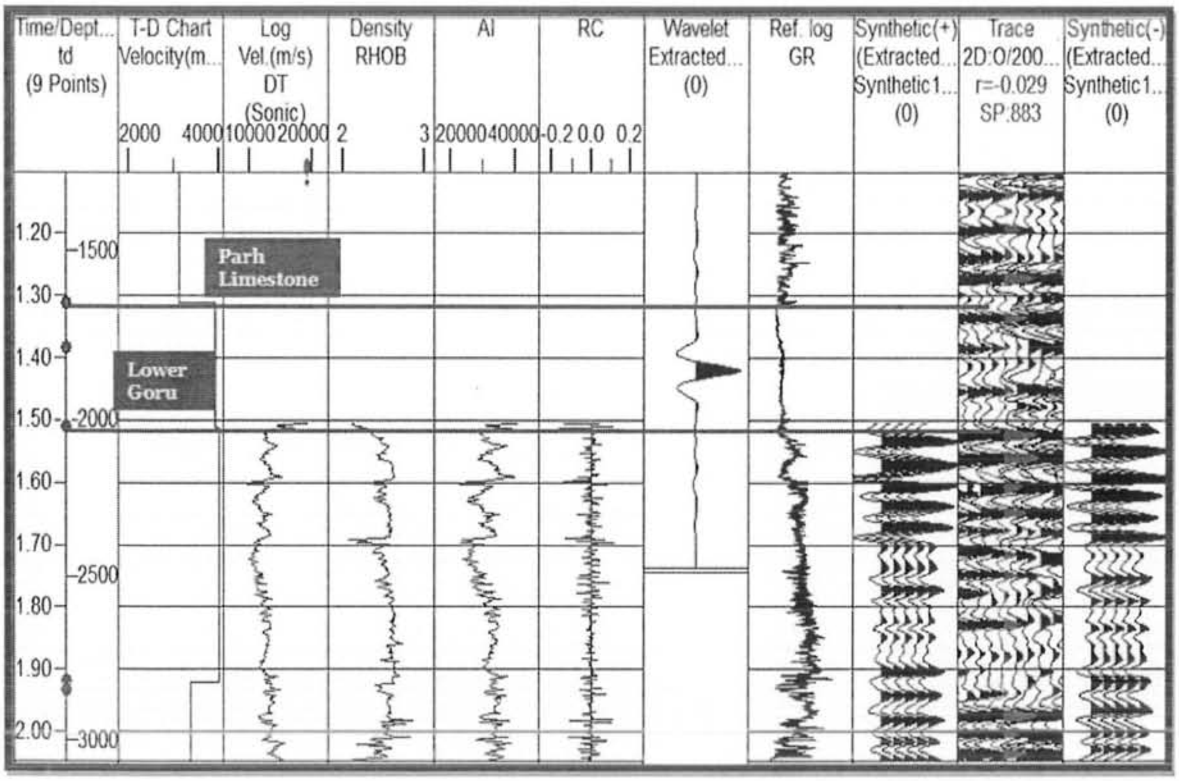


Figure 4.1 Syenthetic seismogrm

4.5 Seismic Horizons :

The main (Prominent) reflections that are present on the seismic sections are marked, and then selected those reflectors that have good characteristics and continuity, and they can also be traced well over the whole seismic section.

There are difficulties in continuing the reflectors at the end of the seismic section and confusions are arrived where reflectors are mixed that may be due to sudden change in lithology, seismic noises, poor data quality or presence of salt in the subsurface at these locations. The seismic data was interpreted using kingdom which is used for interpretation. The SEG -Y format data of seismic line **20017-SNJ-03, 20017-SNJ-04** and **20017- SNJ-01** is loaded by kingdom software for interpretation. After loading data in kingdom software of lines using the interactive tools and applications of Kingdom Software prominent horizons are marked following the trend and continuity of the reflectors. The lines comprise normal faulting this shows horst and Graben Geometry. Marked seismic section of the line is shown in figure

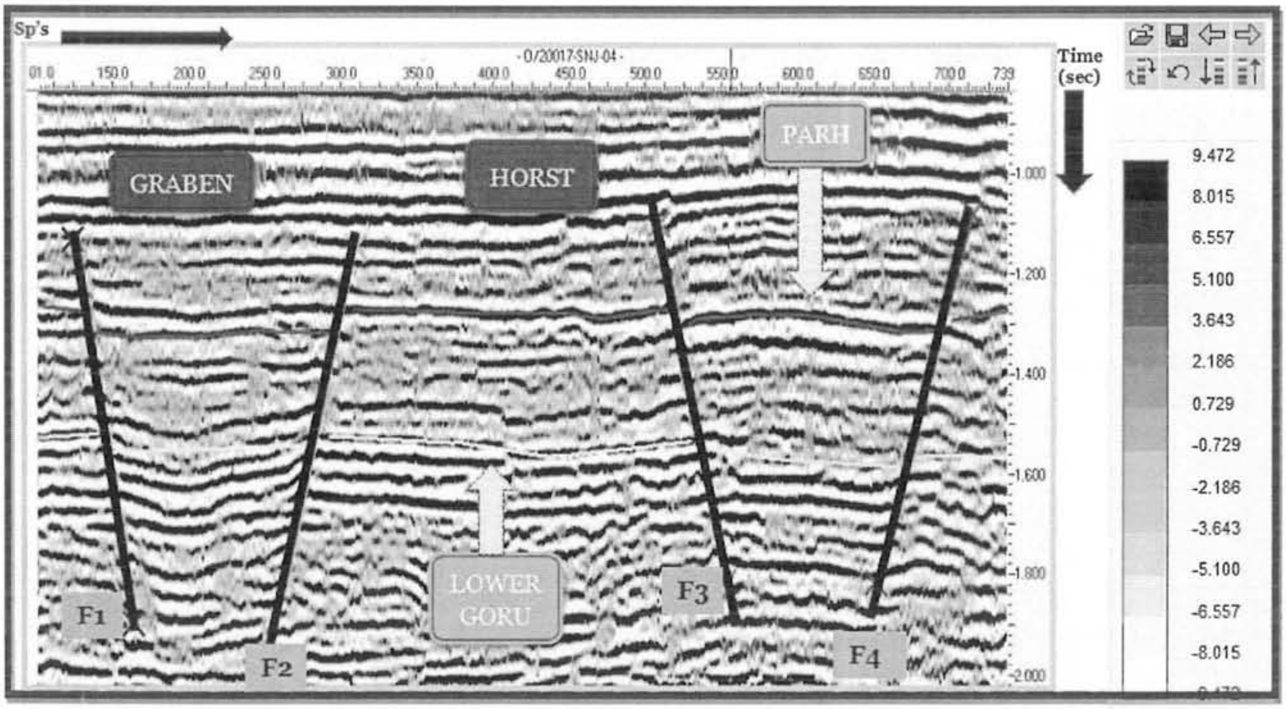


Figure 4.2 Marked seismic section of line 20017- SNJ 04

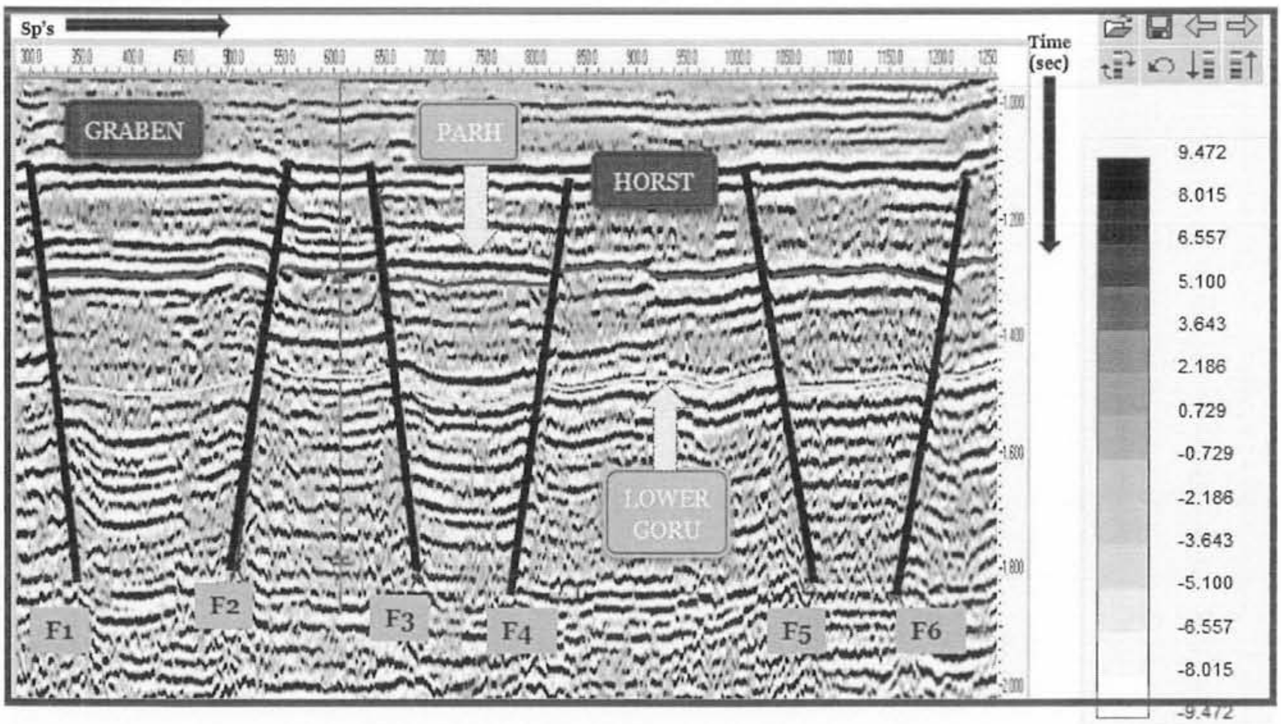


Figure 4.3: Marked section of 20017-SNJ-3

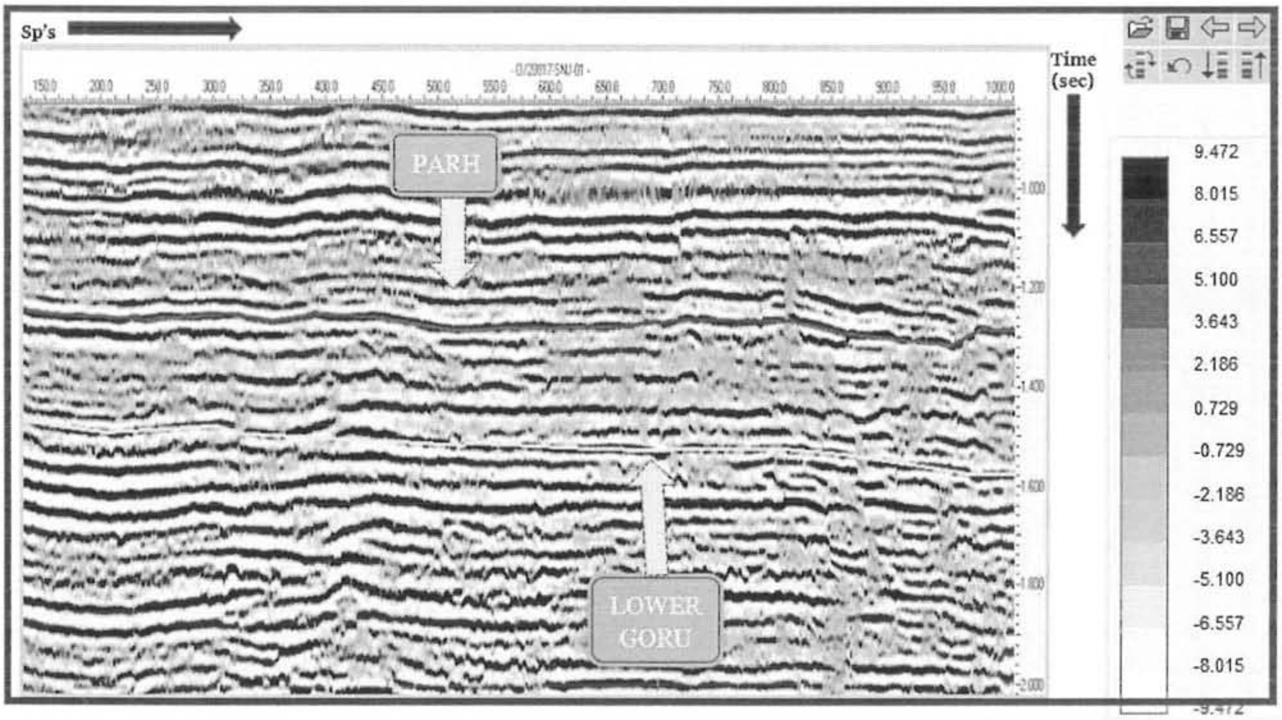


Figure 4.4: Marked section of 20017-SNJ-01

4.6Contour Maps

Contouring is the main tool used in the seismic interpretation. After contouring it becomes obvious that what sort of structure is forming a particular horizon. The contour map of reflector Upper Goru is prepared.

4.6.1 Time Contour Map Of Lower Goru

The two way time contour maps have been generated using the kingdom software. Time contour map of Lower Goru, as shown in the figure 4.5

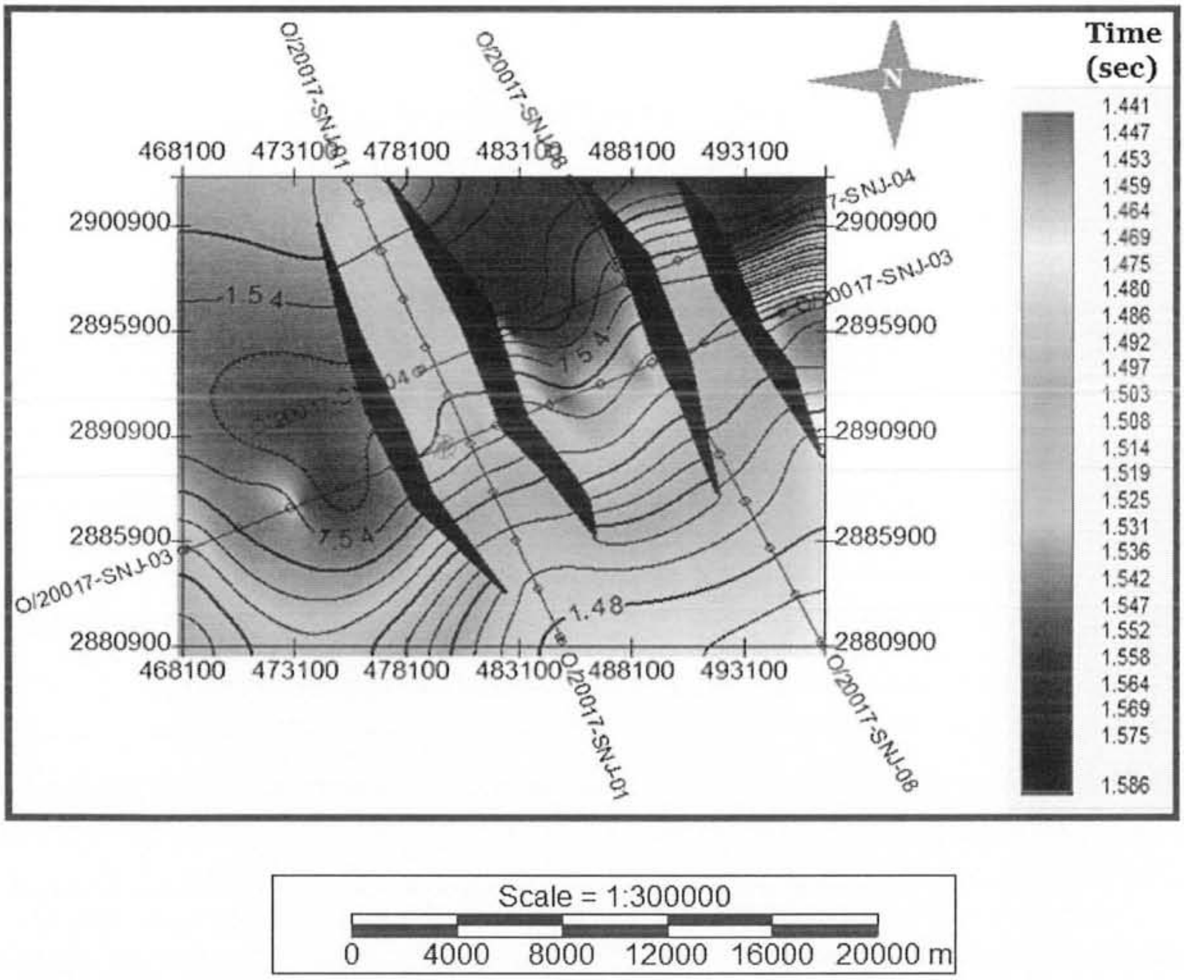


Figure 4.5 Time Contour Map of Lower guru

4.6.2Depth Contour Map Of Lower Goru

The depth contour maps have been generated using the kingdom software. Time contour map of lower Goru, as shown in the figure 4.6, the blue color shows the highest area and yallow color shows deeper area.

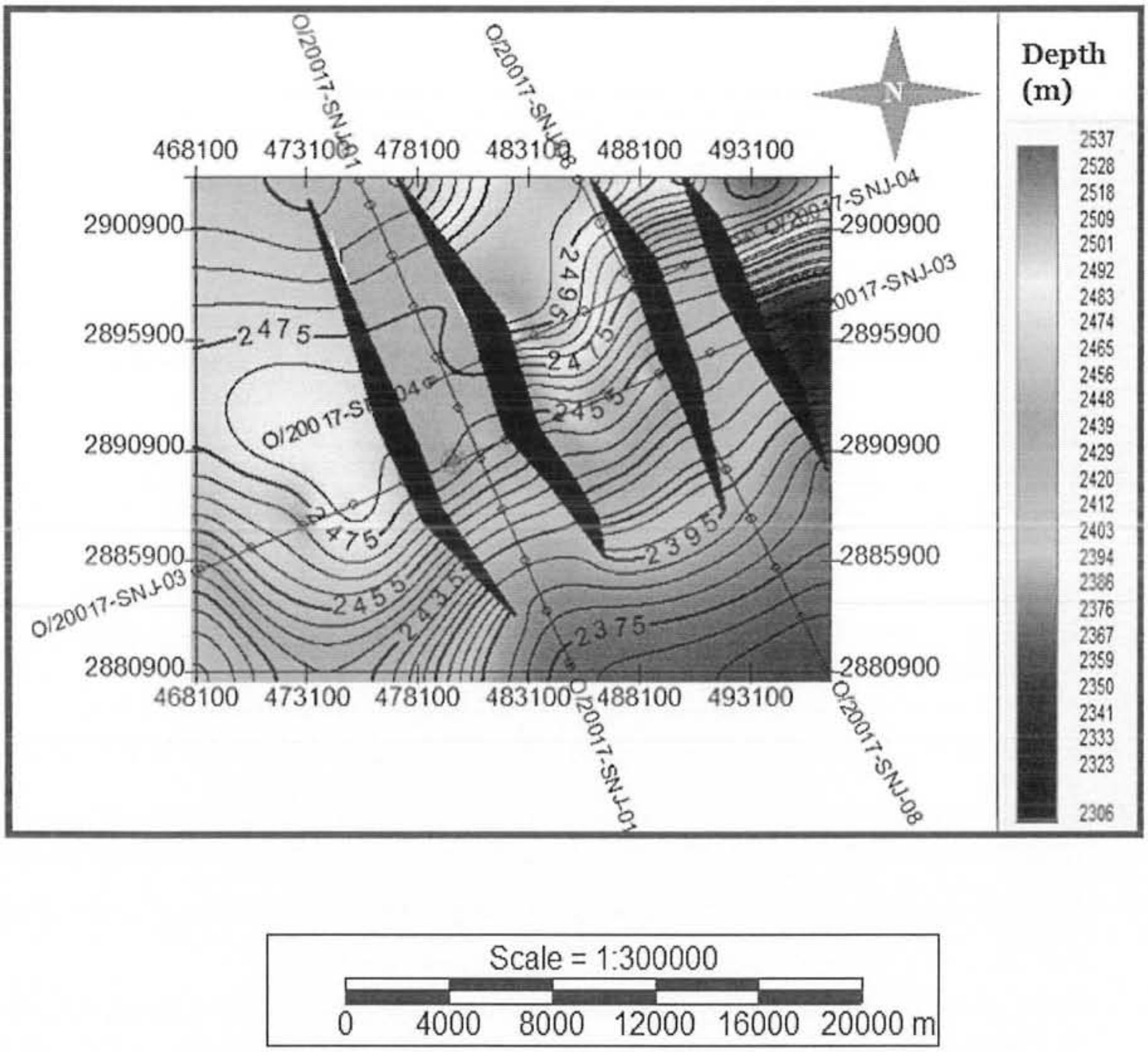


Figure 4.6 Depth Contour Map of Lower Goru

4.6.1 Time Contour Map Of Parh

The two way time contour maps have been generated using the kingdom software. Time contour map of parh, as shown in the figure 4.7.

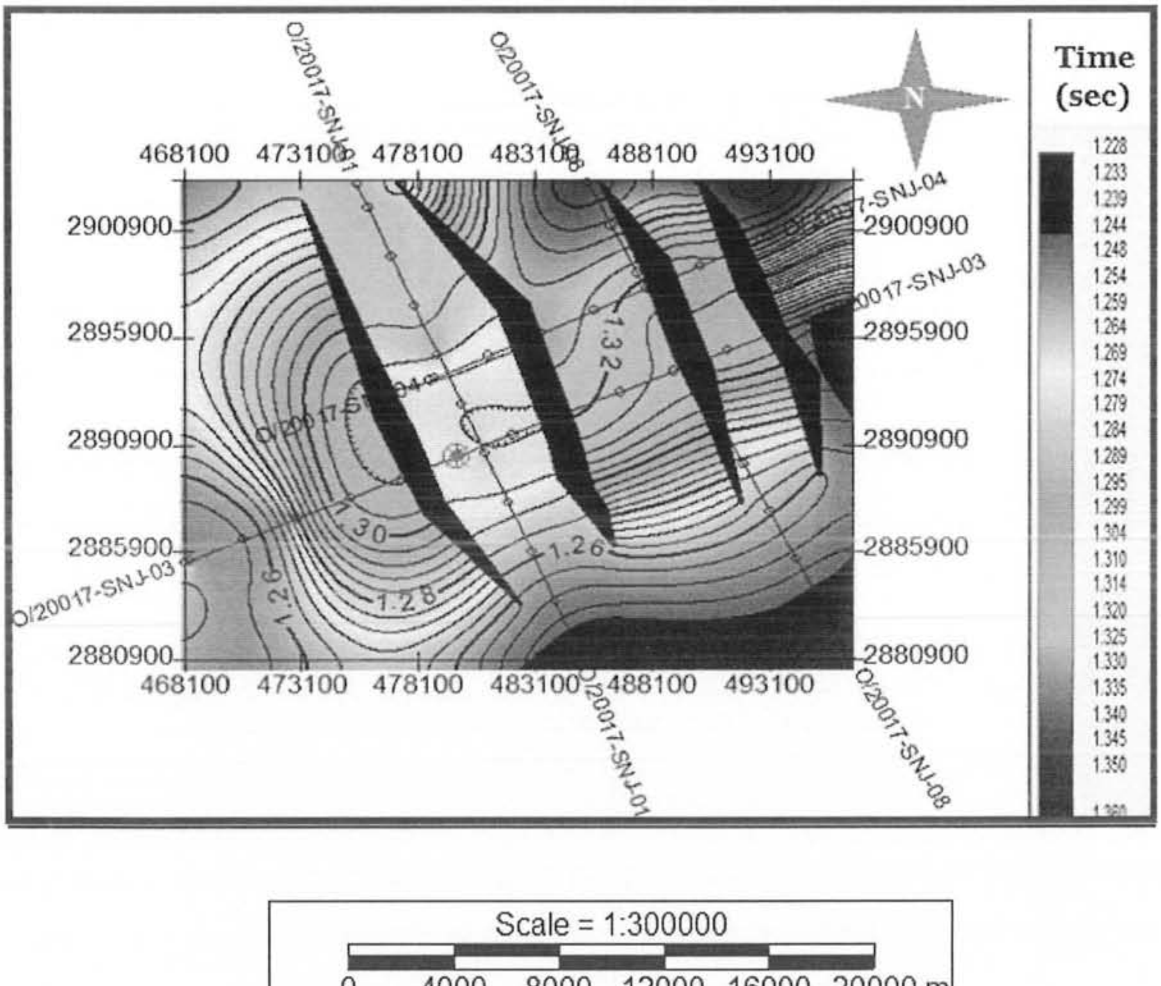


Figure 4.7 Time Contour Map of Parh

4.6.5Depth Contour Map Of Parh

The depth contour maps have been generated using the kingdom software. Time contour map of parh, as shown in the figure 4.8, the yallow color shows the deeper area and blue color shows highest area.

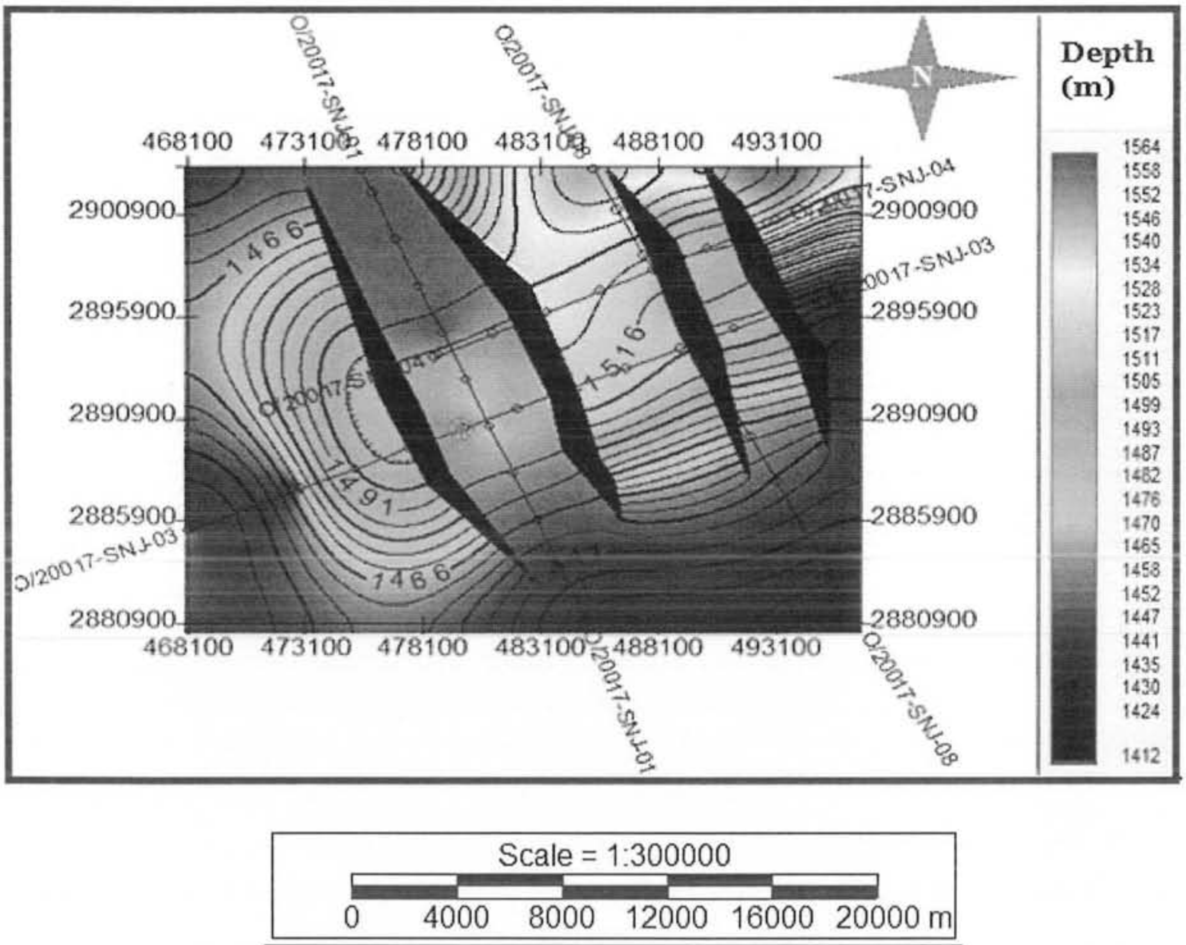


Figure 4.8 Depth Contour Map of Parh

CHAPTER#5
FACIES MODELLING

CHAPTER#5

FACIES MODELLING

5.1 Introduction To Facies Analysis:

Facies analysis is the identification of subsurface lithologies. Horizontal wells are rarely cored; a method is needed to indirectly derive the facies distribution within the formation penetrated by those wells. There is a material correlation between the behavior of well logs and the lithologic and depositional facies of penetrated formation, since modern logs are sensitive to factors that vary with makeup of those formations.

5.2 Sadimentry Facies:

Sedimentary facies Sedimentary facies are bodies of sediment recognizably different from adjacent sediment deposited in a different depositional environment, as shown in figure 5.1 given below.

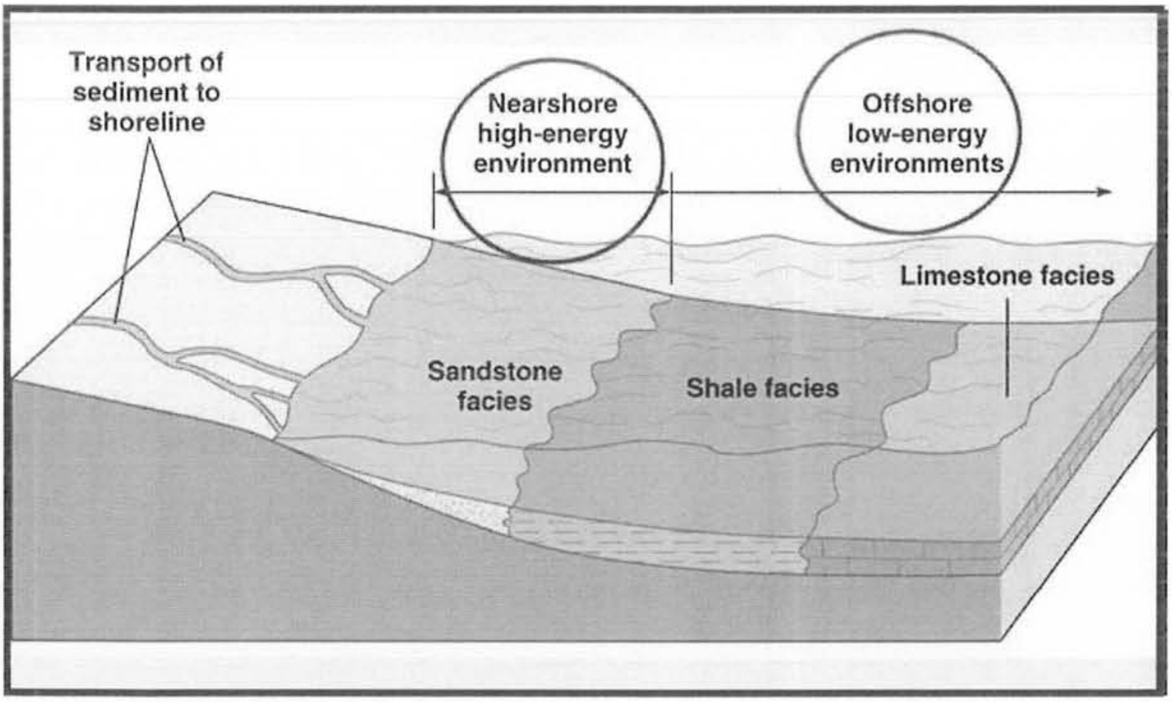


Fig. 5.1: Sediment deposited in a different depositional environment. (Ghazanfar,1993)

5.3 Walther's Law Of Facies:

Walther's Law of Facies, or simply Walther's Law, states that the vertical succession of facies reflects lateral changes in environment. Conversely, it states that when a depositional environment "migrates" laterally, sediments of one depositional environment come to lie on top of another. A classic example of this law is the vertical stratigraphic succession that typifies marine transgressions and regressions. However, the law is not applicable where the contact between different lithologies is non-conformable (Lucia 1995).

Transgression:

A marine transgression is geologic event during which sea level rises to relative to the land and the shoreline moves toward higher ground, resulting in flooding.

Regression:

A marine regression is a geologic event during which sea level falls relative to the land and the shoreline moves toward lower ground and exposes former sea bottom.

5.4 Facies Analysis:

Fundamental to all subsurface geologic studies is an analysis of depositional facies. Development of a facies classification scheme is a particular challenging interplay between capturing enough information for environmental interpretation yet remaining simple. Particularly important is the characterization of facies such that their recognition criteria relate to critical environmental thresholds such as sea level, normal wave base, and storm wave base. These physical environmental zones regulate sedimentary textures and biotic assemblages. A good understanding of paleoecology always strengthen the interpretation and such studies should be included as part of all depositional facies studies. Depositional textures in turn affect porosity-permeability in carbonates. The vertical and lateral organization of facies is an exercise essential to sequence stratigraphic interpretations. (Lucia,1995).

5.5Method To Launch Facies Modeling:

From the KINGDOM software main window menu bar, choose Tools >Cross plot> New to open the Select Data dialog box

5.6 Facies Polygon Management:

Facies polygon management of the facies modeling of well chak 66-01 is shown in the following figure 4.2

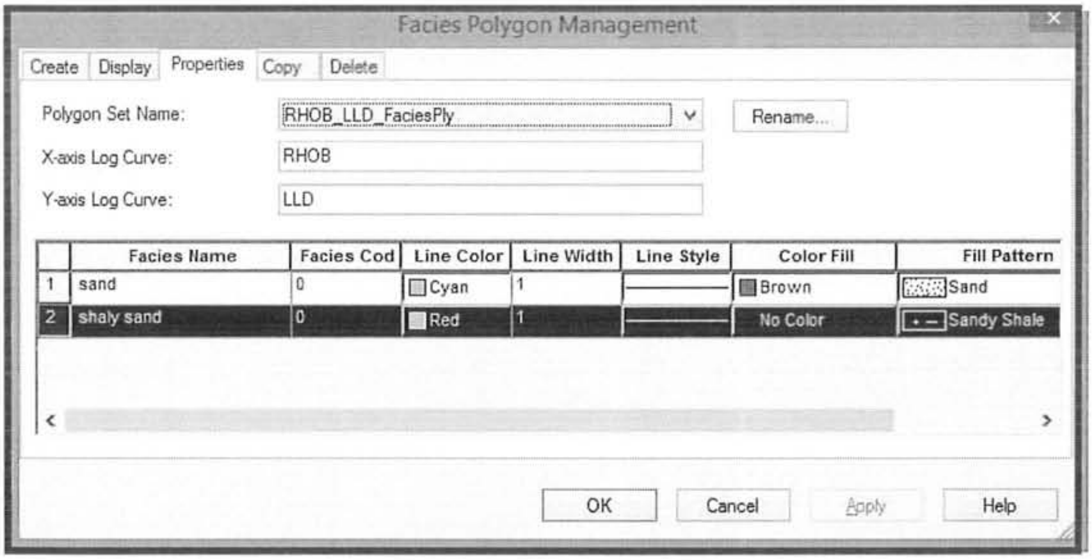


Fig. 5.2: Facies polygon management

5.7 Facies Modeling (Interpretation) Of Well:

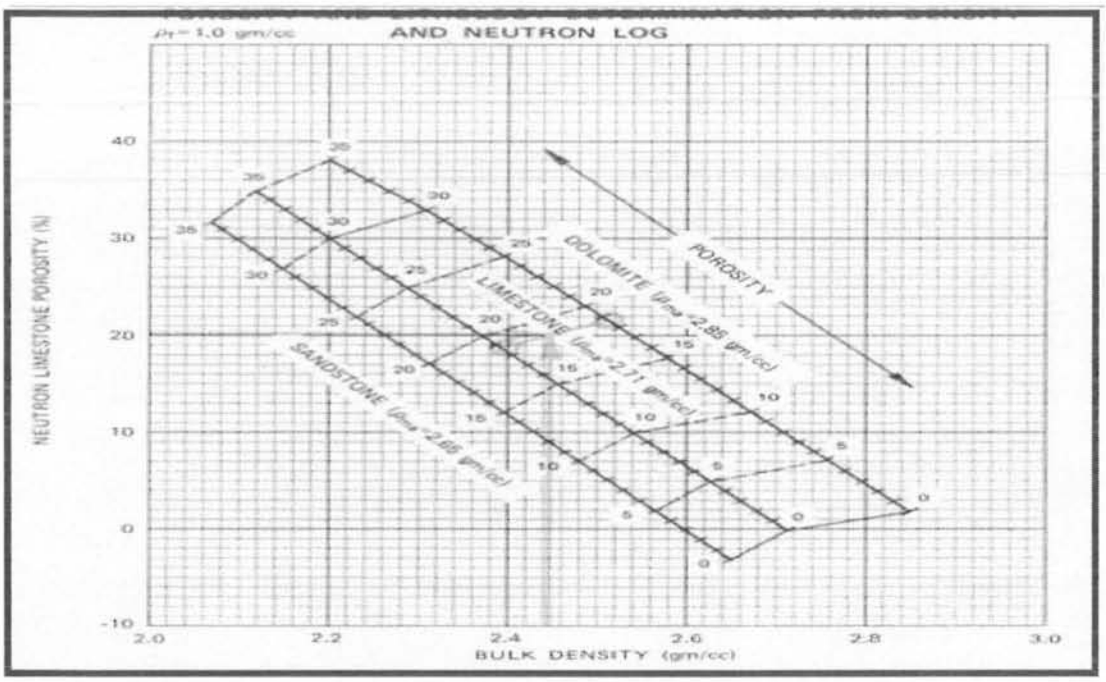


Fig 5.3: Standard plot NPHI vs RHOB

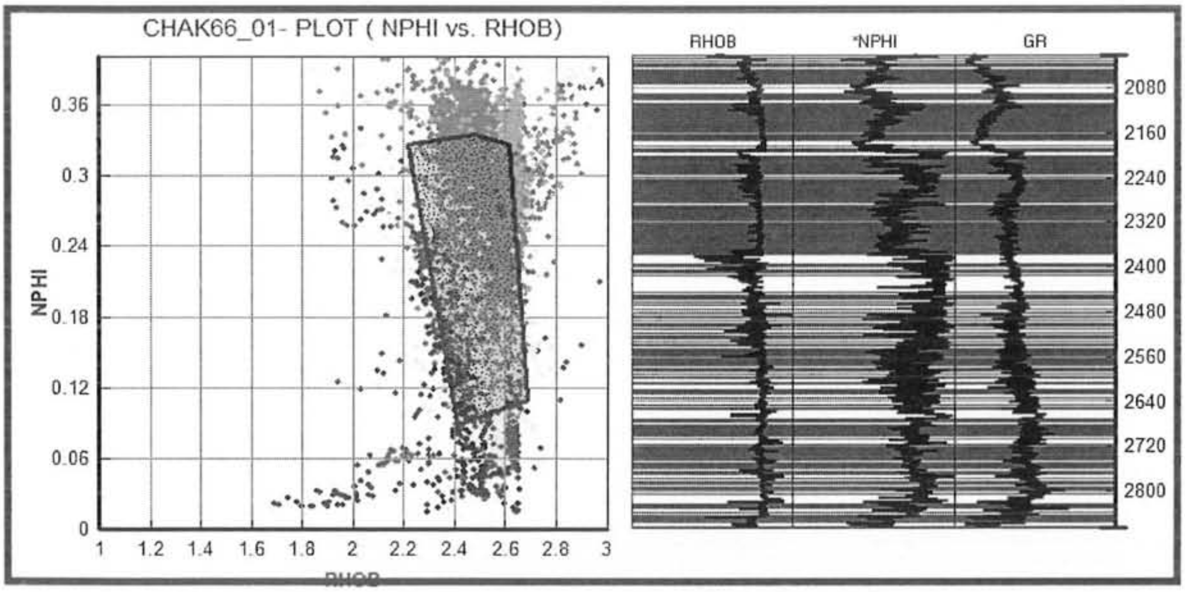


Fig. 5.3: Facies model showing different clean sand

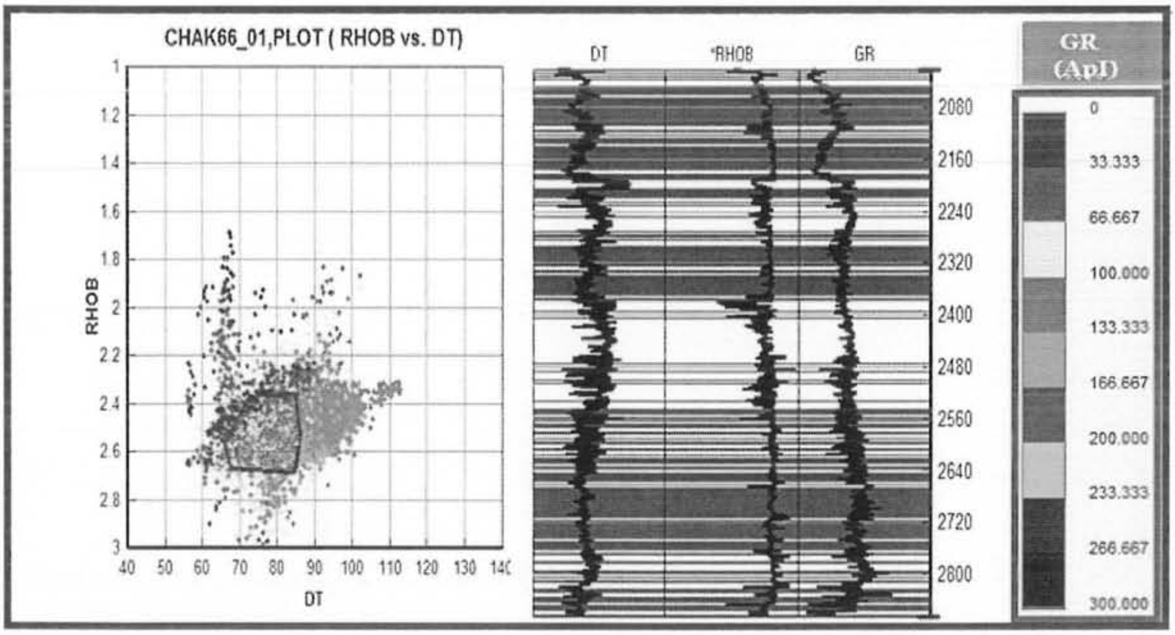


Fig. 5.4: Facies model showing the clean sand

Results:

There are clusters of data points in the figure 5.3 and .The high RHOB values and corresponding NPHI values indicate clean sands.

CHAPTER#6
PETRO PHYSICS

CHAPTER#6

Petro Physics

6.1 Petro Physics

Petrophysics is the study of the physical and chemical properties that describes the occurrence and behavior of the rocks, soils and fluids. To accurately characterize an oil or gas reservoirs, measurements such as resistivity and density are made, from which effective porosity, saturations and permeability can be quantified

6.2 Types of Logs

- Gamma Ray
- Spontaneous Potential
- Caliper
- Resistivity
- Sonic
- Density
- Neutron

6.2.1 Spontaneous Potential Log:

The SP log records the electric potential between an electrode pulled up a hole and a reference electrode at the surface. This potential exists because of the electrochemical differences between the waters within the formation and the drilling mud. The potential is measured in milli volts on a relative scale only since the absolute value depends on the properties of the drilling mud.

In shaly sections, the maximum SP response to the right can be used to define a "shale line". Deflections of the SP log from this line indicate zones of permeable lithologies with interstitial fluids containing salinities differing from the drilling fluid. SP logs are good indicators of lithology where sandstones are permeable and water saturated. However, if the lithologies are filled with fresh water, the SP can become suppressed or even reversed. Also, they are poor in areas where the permeabilities are very low, sandstones are tightly cemented or the interval is completely bitumen saturated (i.e. oil sands).

6.2.2 Caliper Log:

Caliper Logs record the diameter of the hole. It is very useful in relaying information about the quality of the hole and hence reliability of the other logs. An example includes a large hole where dissolution, caving or falling of the rock wall occurred, leading to errors in other log responses. Most caliper logs are run with GR logs and typically will remain constant throughout.

6.2.3 Resistivity Log:

Resistivity logs record the resistance of interstitial fluids to the flow of an electric current, either transmitted directly to the rock through an electrode, or magnetically induced deeper into the formation from the hole.

6.2.4 Sonic Log:

Sonic logs (or acoustic) measure the porosity of the rock. Hence, they measure the travel time of an elastic wave through a formation (measured in ΔT - microseconds per meter). Intervals containing greater pore space will result in greater travel time and vice versa for non-porous sections. They must be used in combination with other logs. Particularly gamma rays and resistivity, thereby allowing one to better understand the reservoir petrophysics.

6.2.5 Density Log:

Density logs measure the bulk electron density of the formation, and are measured in kilograms per cubic meter (gm/cm3 or kg/m3). Thus, the density tool emits gamma radiation which is scattered back to a detector in amounts proportional to the electron density of the formation. The higher the gamma ray reflected, the greater the porosity of the rock. Electron density is directly related to the density of the formation (except in evaporates) and amount of density of interstitial fluids. Helpful in distinguishing lithologies, especially between dolomite (2.85 g/cc) and limestone (2.71 g/cc), sandstone (2.65 g/cc).

6.2.6 Neutron Log:

Neutron Logs measure the amounts of hydrogen present in the water atoms of a rock, and can be used to measure porosity. This is done by bombarding the formation with neutrons, and determing how many become "captured" by the hydrogen nuclei. Because shales have high amounts of water, the neutron log will read quite high porosities. Thus it must be used in conjunction with GR logs. However, porosities recorded in shale-free sections are a reasonable estimate of the pore spaces that could produce water.

6.3 Volume of Shale:

Shale is more radioactive than carbonate or sand, gamma ray logs can be used to calculate volume of shale in porous reservoirs. The volume of shale can then be applied for analysis of shaly sands. Calculation of gamma ray index is the first step to determine the shale volume from gamma ray log (Schlumberger, 1974).

$I_{GR} = GR_{log} - GR_{min} / GR_{max} - GR_{min}$

I_{GR} = Gamma ray index

GR_{log} = Gamma ray reading of formations

GR_{max}= Maximum gamma ray

GRmin= Minimum gamma ray

The following formula is used to find volume of shale

Consolidated:

Vshale=0.33[2(2*I_{GR})-1]

Unconsolidated:

Vshale=0.883[2(3.7*I_{GR})-1]

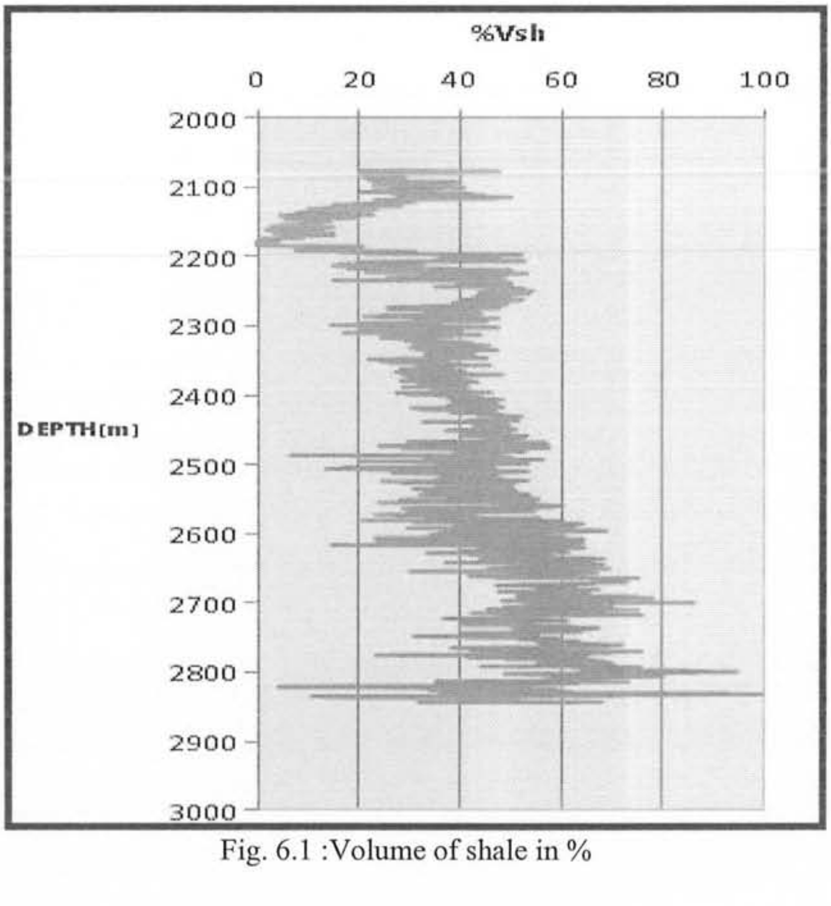


Fig. 6.1 :Volume of shale in %

6.4 Calculation of Resistivity of Water (Rw):

The Resistivity of Mud Filtrate at Zone of Interest (Reservoir Formation) is calculated by the equation given below:

$R_{mf2} = R_{mf1} * (T_1 + 6.77 / T_2 - 6.77)$

Where R_{mf1}=Resistivity of mud filtrate at surface temperature

T_1 =surface temperature

T2= formation temperature

R_{mf2}= resistivity of mud filtrate at formation temperature

6.5 Calculation of Water Saturation:

The fraction of pore spaces containing water is termed as Water Saturation (Sw) which is calculated by from the Archie's formula given by;

Sw = {Rw/ (RT*ϕm)} 1/n

Where

Rw= Resistivity of Water

R_t =True Resistivity

Φ =Porosity

m =Cementation factor

n = Wet ability factor

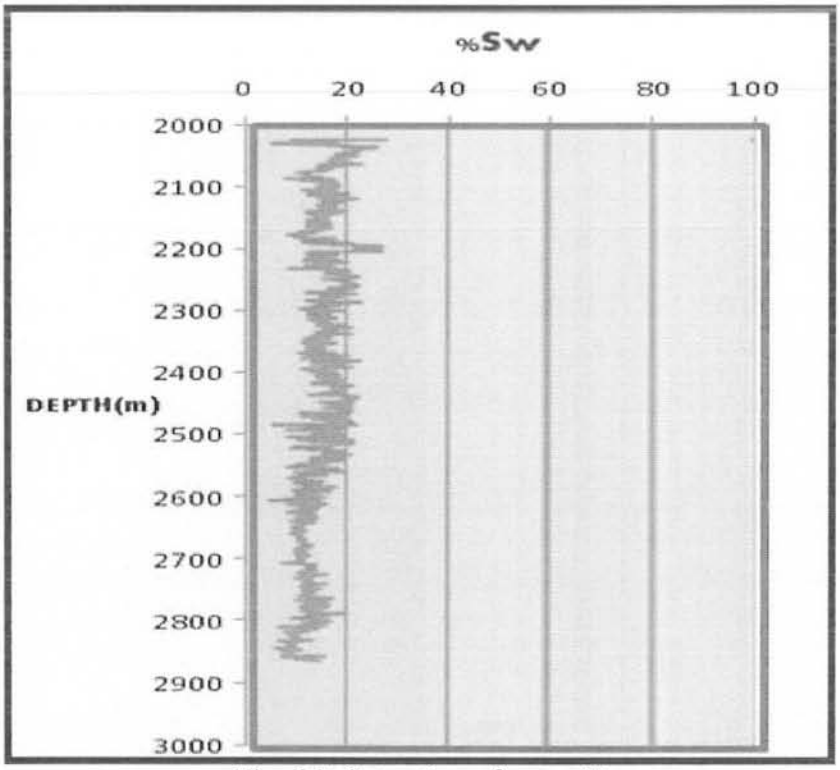


Fig. 6.2: Saturation of water %

6.6 Calculation of Saturation of Hydrocarbon:

The fraction of pore spaces containing Hydrocarbons is known as Hydrocarbon Saturation and mathematically given by the following equation;

$S_{hc} = 1 - S_w$

Where

Shc= saturation oh hydrocarbon

Sw= saturation of water

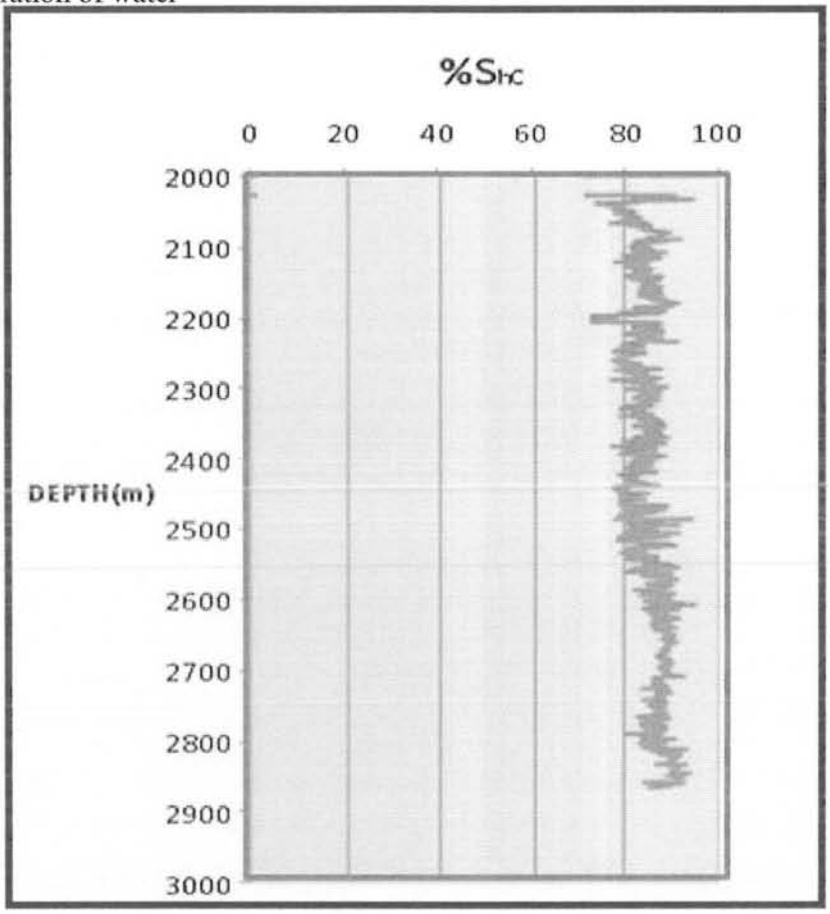


Fig. 6.3: Saturation of hydrocarbon %

6.7 Calculation of Total Poresity:

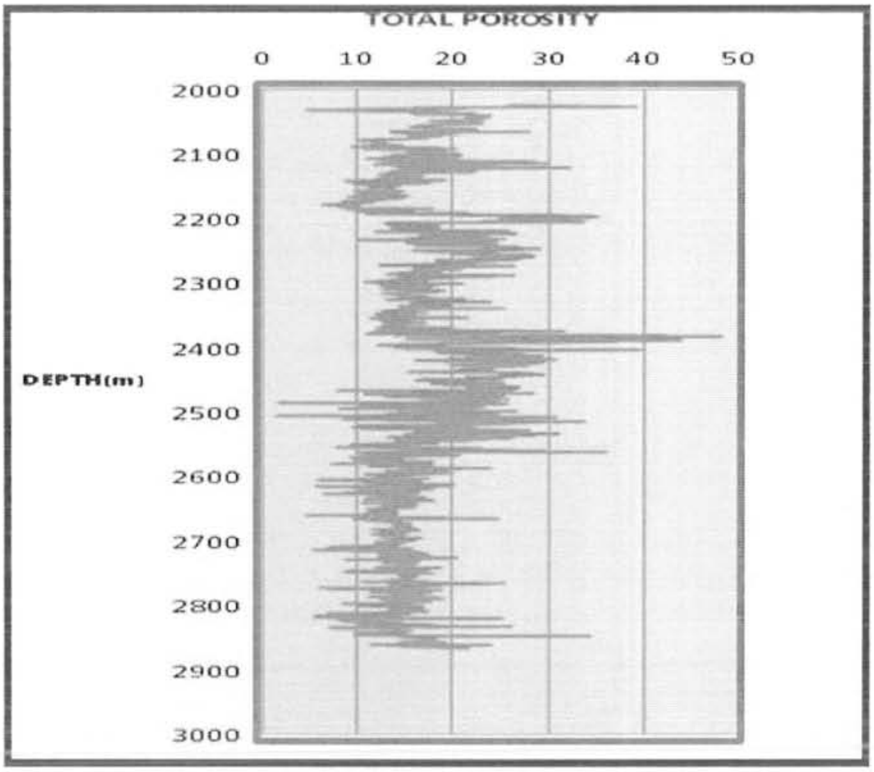
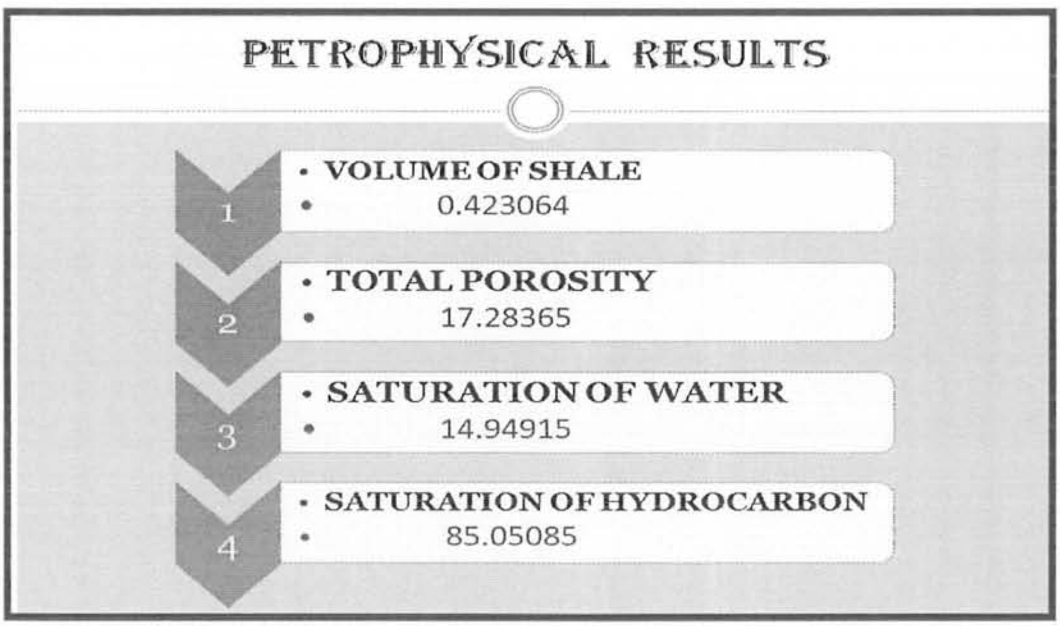


Fig:6.4 Total porosity

Petropysical Results:



6.8 Well Correlation

Well correlation is used to determine the equivalency in time or rock stratigraphic units of the succession of strata found in two or more different places. The rocks of associated outcrops may be correlated through physical criteria and fossil content. Precise lithological from well to well can be inferred by comparing the tops and bottom of lithologies in each well, well tops data is used to perform this task.

6.8.1 How we generate cross section

A well correlation section map is generated by using the kingdom software. Starting from well chak south 5 dim a profile is passed through all the well that are correlated. The software also provides the distance between the each well along the profile. This information is used to create well correlation cross section by placing the well columns at their appropriate position

Well Name	Chak south 5 dim	Chak 66-01
Depth Reference	KB	KB
Elevation(m)	27.70	0
Total Depth(m)	2908.0	2999.0
Status	Gas &Condensate	Oil&Gas

6.8.2 Stratigraphic wells correlation

The interpretation of well log data is the primary method for development of a stratigraphic framework of the area. This framework can be used for mapping and delineation of reservoir intervals. The purpose of it is not only to establish the stratigraphic correlation of different wells in Sanjhoro area but also clarify the source of sediments and depositional centers during different geological periods. This helps in identifying the maximum thickness zones of prospective formations in Sanjhoro area and the direction of sediments flow in the basin during different geological periods. The thickness variation is due to erosion, over burden, pressure and ancient high. In Sanjhoro area mostly horst and garben structures. As we move towards north shaly content decreases and carbonate material increases which shows marine transgression and towards south limestone increases. The depth variation is not prominent in the area if we fallow the well profile from N-E it clear from figure the depth of lower goru is different in two wells. Figure 6.5 shows the correlation of strata from Chak south 5 dim to Chak 66-01.

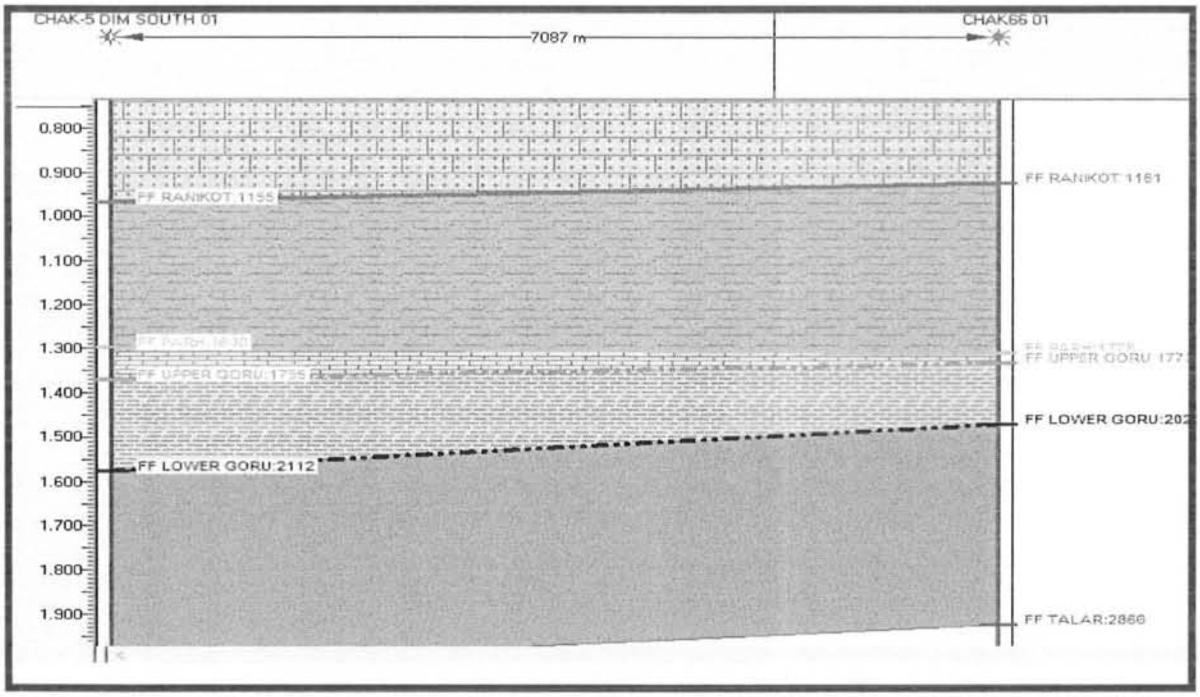


Fig. 6.5: Well correlation of stratigraphic sequence (Ghazanfar, 1993)

CONCLUSION

After applying seismic and well data on the study area and using different software tools I concluded tha

- On the basis of seismic as well as well data 2 reflector of geological importance were identified. Reflector 1 is parh which is acting as reservior, reflector 2 is lower goru which is also acting as the reservoir .
- The seismic interpretation revealed Horst and Graben structure in Sinjhoro area.
- Time and depth contour maps help us to confirm the presence of Horst and Graben structure in area.
- Synthetic seismogram was matched with the marked horizons and it has confirmed the structural interpretation.
- High concentration of shale clearly shows that there is only a thin reservoir present.
- Rock properties calculated helped to study the nature and type of lithologies.