

Assessment of Geological Structure in Nafoora Oil Field, Sirt Basin, Libya

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Abstract

The Nafoora oilfield is situated on a major tectonic uplift in the Eastern Sirte Basin, the Amal-Nafoora High. Four oilfields have been discovered on this uplift – Amal, Rakb, Augila, and Naffora. The Nafoora oilfield was surveyed by AGOCO company as a 2D seismic Survey in directional groups. this study used 35 seismic lines in different directions with 6 wells. The methodology used in this study aimed at the integration of geophysical and geological aspects. The seismic reflection technique is used to provide the basic structural control of the subsurface geology integrated with available exploration wells to control the interpretation. The resulted structure gives us an expecting to the new future drilling wells where it should be between the two WNW-ESE major strike-slip faults in the south, and on the right side (up throw) of the N-S minor faults which found in the north of the Nafoora oil field.

Keywords: Nafoora, Oil Field, Geological Structure, Sirte Basin, Libya.

1. Introduction

Location

Libya will be those fourth biggest nation on Africa, and it may be flanked by the mediterranean ocean of the north, egypt of the east, sudanese of the southeast, chad Also niger of the south, and algeria and tunisia of the west, Fig (1).

The Sirt Basin, the The majority productive oil bowl clinched alongside Africa, the bowl blankets something like 600,000 km² (375,000 mi²) clinched alongside vital Libya, holds 89% from claiming Libya's stores Furthermore will be positioned 13th "around the world's petroleum basins What's more holds 16 titan oil fields. Supply rocks run in period starting with Precambrian to eocene [7]. Those upper cretaceous Sirt shale is the significant hotspot rock. It speaks to An thick succession that gathered done major grabens same time shallow-marine carbonates Also reefs gathered ahead contiguous horsts Also platforms to structure real supply rocks. The contemplate zone is a and only concession 51 have a place the Middle Eastern Gulf oil organization (AGOCO) Fig (2). This concession may be arranged the middle of 21° 15- on 21° 40- e and 27° 45- on 27° 55- n (Fig. 3). Those zone is give or take 220 km southeast Benghazi, produced dependent upon about rough desert What's more sand dunes, for Normal of 120m over MSL (Mean ocean Level), with an aggregate region for something like 420km². This range examined Eventually Tom's perusing [1],[8],[6] and reasoned that those subsurface of Nafoura field range comprises pre-rift rocks and the advancement of syn-rift rocks Also post-rift warm subsidence. Those A large portion intriguing is the E-W Also NNW-SSE faults and their intersections. Those shortcoming design will be showed up for be On consistence for An right-lateral sense for shear. Checking such developments required An close

academic-oriented investigation of all sorts from claiming faults. Subtle elements on the component about sedimentary bowl shaping to mainland interiors need accentuated the vitality of dip-slip faults What's more their conceivable hereditary connection to shears. It may be from claiming essential vitality with dissect those geometry and Development of disconnected faults and their association for each other, once they structure those extensional framework. Those Nafoora oilfield may be arranged with respect to a real tectonic development elevate in the eastern Sirte Basin, those Amal-Nafoora helter skelter. Four oilfields bring been found on this elevate – Amal, Rakb, Augila Furthermore Naffora. Penetrating once this secondary encountered hydrocarbon entanglement for through a dozen unique stratigraphic units. These reservoirs run in agdistis from the Pre-Cambrian storm cellar will miocene sands. The The majority vital reservoirs in the Nafoora field would those sandstones of the Amal (Cambro-Ordovician) Furthermore Maragh (Upper Cretaceous) Formations. Reservoirs in the upper Cretaceous, Palaeocene and eocene carbonates would Similarly as paramount Likewise the individuals in the sandstones [9].

Geological Setting

Subsurface Stratigraphic Succession

The sediments of Sirt bowl required been arranged under Pre-rift, Syn-rift What's more Post-rift. The Pre-rift Also Post-rift sediments were overwhelmed Eventually Tom's perusing clastic, while the Syn-rift sediments were overwhelmed Eventually Tom's perusing carbonate Fig (4). The elementary reservoirs about Sirt bowl inside concessions included those Cambro- ordovician to cretaceous Gargaf formation, the upper cretaceous

sand Also carbonates, the paleocene carbonates, the eocene carbonate What's more oligocene sandstone.

The Pre Rifting Sediments (Cambro – Ordovician):. The Cambro - ordovician sediments were spoke to Toward Gargaf framing which comprised about mainland sandstone, aggregate and shale beds [10]. The Gargaf creation limited by unconformable limits Furthermore overlain Toward Bahi framing Furthermore underlain Eventually Tom's perusing storm cellar volcanic rock rocks.

Those Syn Rifting Sediments (Late Cretaceous– Late Eocene):. This phase quell the late Cretaceous– late eocene sediments (basin-fill stage). These sediments were principally marine for distinctive depositional situations Concerning illustration an aftereffect about variance done ocean level whichever raising (Transgression) or bringing down (Regression), regulated Toward nw – se turned horst and graben structures.

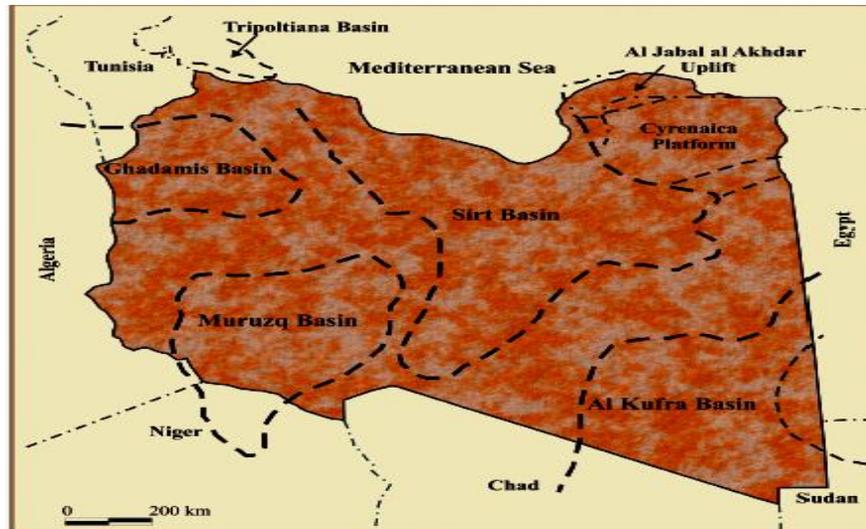


Fig (1) Sedimentary basins of Libya (productive basins, future prospective) 200 km

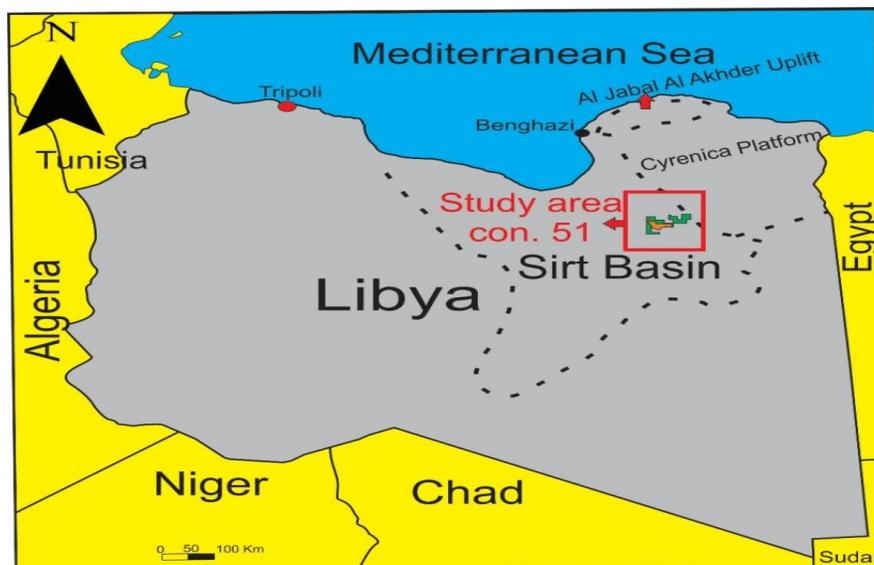


Fig (2) Locations of the concession 51 in the northeast of Sirt Basin.

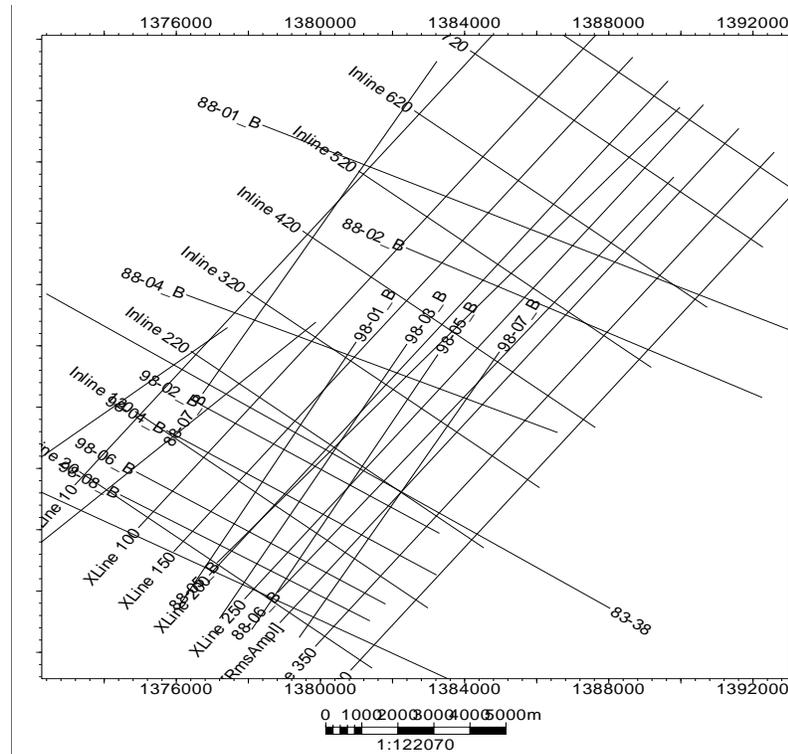


Fig (3) Base Map of El-Nafoora oil field showing the seismic line and wells

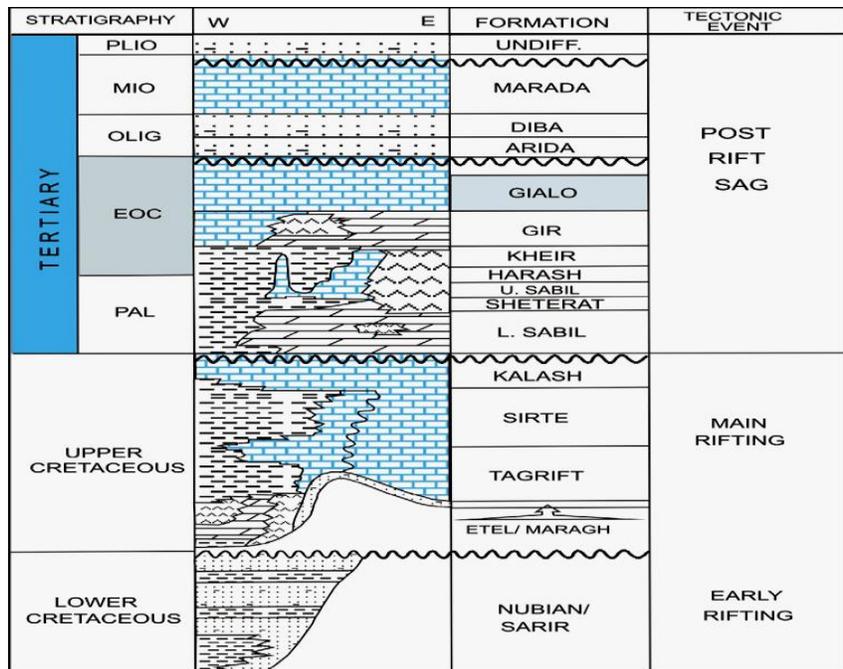


Fig (4) Generalized stratigraphic/lithologic correlation chart of the Upper Cretaceous and Tertiary succession of the Sirt Basin (8)

Shales are dominantly grey, fissile should somewhat blocky, somewhat to non-calcareous,

Furthermore glauconitic Also pyritic clinched alongside a significant number areas. Those

limestone interbeds are more incessant in the bring down and only those framing [11]. Those structuring need a greatest thickness for 600 m in the Agedabia trounce. In the northwest, it conformably overlies Possibly those Argub Carbonate, the Etel Formation, the Bahi sandstone alternately those Maragh Sandstone, or those Rachmat arrangement rests unconformably on the Amal arrangement alternately granite basement, relying upon its position in the bowl. At most locations, Sirt shale conformably overlies those structuring. The Rachmat shaping gives an immense petroleum hotspot to those oil fields placed along the peak hub of the wine cellar highs (such Similarly as the Augila, Nafoora Furthermore Amal field [2], [12]. However, the Rachmat shale may be a fantastic seal through those Etel Formation, same time those Tagrift limestone will be An supply in the Augilafield.

Those TagriftLimestone is confined on a territory along the southeastern edge of the Sirt Basin, including those Rakb helter skelter territory. The Sirt shale is broadly appropriated all around those grabens of the Sirt bowl. In the south, it holds a shale progression for minor limestone interbeds. Its thickness ranges from 500 m in the Zallah trounce to through 700 m in the Agedabia trounce. The Sirt shale may be conformably overlain Eventually Tom's perusing Kalash limestone However underlies the Satal creation in the Dahra stage region. Contingent upon its position in the basin, those basal contact camwood make gradational alternately unconformable. In the west of the Sirt Basin, those Sirt shale sits looking into rocks Similarly as old Likewise the Bahi structuring. Of the east, the duration of the time equal of the Sirt shale turns into calcareous in the bring down part, and the shales review laterally under What's more r upon the Maragh sandstone [11], [5] closed that those upper cretaceous marine Sirt shale may be those fundamental hydrocarbon sourball rock in the Sirt bowl.

2. Materials and methods

2.1 Seismic Data

This examine may be dependent upon those material got starting with those TDL (Technical information Library) of the Middle Eastern Gulf oil organization (AGOCO). Geophysical information incorporate 2D seismic profiles Furthermore wireline logs. Other information incorporate geological reports Furthermore great logs. Those seismic information contain 35 lines from claiming last stacked seismic profiles from claiming reflection seismic overview obtained Eventually Tom's perusing AGOCO On 1985, 1989, 1991, Also 1993, the seismic scope is not uniform Also profiles are

haphazardly situated. What added up to 319 line kilometers were accessible to translation. Seismic quality will be a amount concentrated alternately inferred from seismic information that camwood make investigated so as with upgrade the data that may be additional unpretentious in an accepted seismic image, prompting a superior geological or geophysical elucidation of the information [4]. 2. 3 Borehole information. Those acquired borehole information incorporate composite logs to 6 wells (B1-NC32D, C1-51, I1-51, O1-51, R1-51, V1-51) scattered around the ponder range with arrangement topsail. Sonic, gamma-ray Furthermore spontaneous possibility logs accessible to A large portion of the wells. These logs need aid likewise utilized should research Also figure out those separate petrophysical parameters What's more with acquire those geological data to structuring assessment.

2.2 Methodology

The procedure utilized within this contemplate meant during the coordination from claiming geophysical What's more geological parts. The seismic reflection method may be used to provide those essential structural control of the subsurface geology coordinated with accessible investigation wells will control those elucidation. As stated by those information accessible in any zone of study, the system for understanding need been picking. Done Nafoora field, those accessible information need aid seismic overview blankets those region What's more 6 great logs a standout amongst them (V1-51) contain electric logs (Density, Neutron, GR, Caliper, resistivity Furthermore PE) Also mud log from claiming these wells. This paid us will take after the accepted method for Examining the region which integrates those seismic Furthermore wells information together during those last with substantiate the same outcomes Fig (5). Early ID number from claiming structural style may be a critical investigation work and the proper determination for possibility (trap) models frequently relies on the unwavering quality of such identification, [7]. The first seismic information will be An poor caliber which makes it vague to broke down to faults, thus separate seismic qualities such as structure smoothing, sweetness, Variance, and root imply square (RMS) qualities will be used to extricate those faults. Those past qualities utilized within faults translation to every seismic transport and this devour an quite a few occasion when Be that as that might have been a direct result those determination is reasonable toward those level from claiming determination of seismic data, and the effect might have been huge numbers major Also minor faults in the zone.

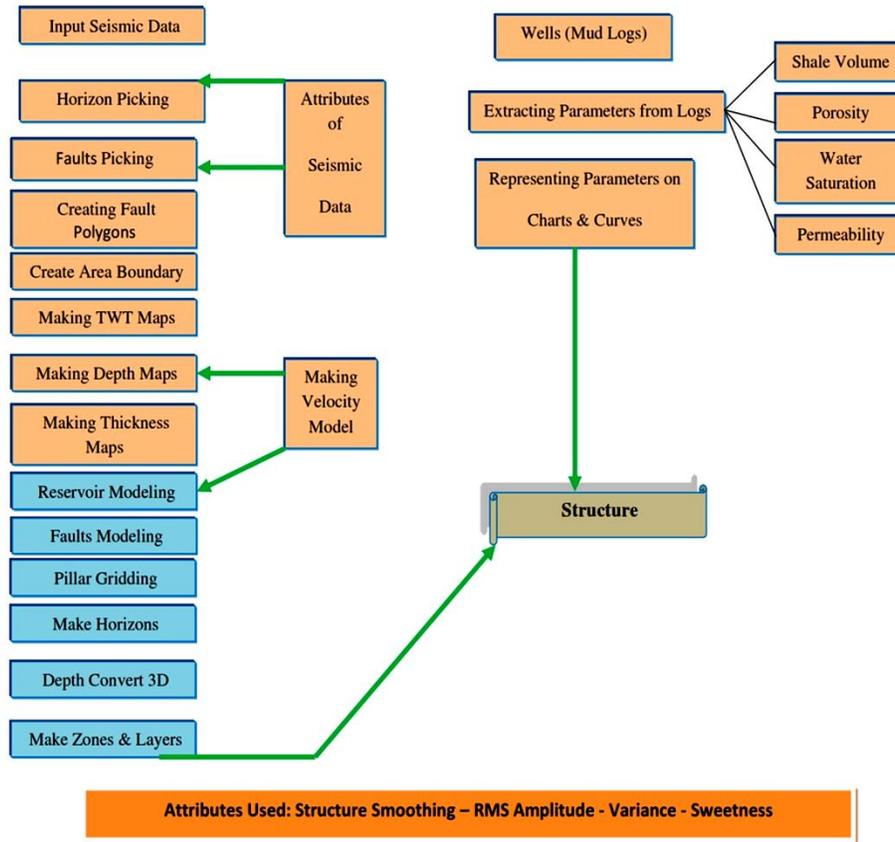


Fig (5) The Methodology Flow Chart that used in Nafoora Field

The preliminary investigation of the well logging data response is of prime importance after doing environmental corrections. The quick Look technique of log records is well known and used, as an alternative to quantitative comprehensive formation evaluation to describe many petrophysical characteristics.

2.3 Volume of Shale

The gamma-ray log, in Different sorts of great logging, is carried by bringing down an instrument flying down those drill gap Also recording gamma radiation variety for profundity. Gamma radiation will be generally recorded to API units, An estimation originated Toward those petroleum industry. Gamma logs would weakened by the breadth of the borehole due to those properties of the liquid filling the borehole, Be that as on account of gamma logs need aid the vast majority regularly utilized for a qualitative way, amendments need aid as a rule not fundamental.

2.4 Porosity

Porosity is the proportion from claiming pore volume to its aggregate volume. Porosity is controlled by rock type, pore distribution, cementation, diagenetic Furthermore arrangement. Porosity is not regulated Eventually Tom's perusing grain size, Similarly as those volume about between-grain space is related best of the system for grain pressing. Rocks regularly diminish in porosity with agdistis What's more profundity about internment. It may be ascertained Toward sonic log, this device need An transmitter that emits heartless waves of the rock arrangement that point receivers pick dependent upon Furthermore record those Different waves which return starting with those rock What's more measure the distinction clinched alongside landing of the layering wave during those receivers. Utilizing the Wyllie equation, those porosity might make calculated: Fig (6).

2.7 Effective Porosity

Effective porosity is most commonly considered to represent the porosity of a rock or sediment available to contribute to fluid flow through the rock or sediment, or often in terms of "flow to a borehole".

Porosity that is not considered "effective porosity" includes water bound to clay particles (known as bound water) and isolated "vuggy" porosity (vugs not connected to other pores). The effective porosity is of great importance in considering the suitability of rocks or sediments as oil or gas reservoirs, or as aquifers. [13] Fig (7).

2.8 Permeability

Permeability is the property of rocks that is an indication of the ability for fluids (gas or liquid) to flow through rocks. High permeability will allow fluids to move rapidly through rocks. Permeability is

affected by the pressure in a rock. The unit of measure is called the darcy. Sandstones may vary in permeability from less than one to over 50,000 millidarcys (md). Permeabilities are more commonly in the range of tens to hundreds of millidarcies. A rock with 25% porosity and permeability of 1 md will not yield a significant flow of water. Such "tight" rocks are usually artificially stimulated (fractured or acidized) to create permeability and yield a flow. Permeability is part of the proportionality constant in Darcy's law which relates discharge (flow rate) and fluid physical properties (e.g. viscosity), to a pressure gradient applied to the porous media.

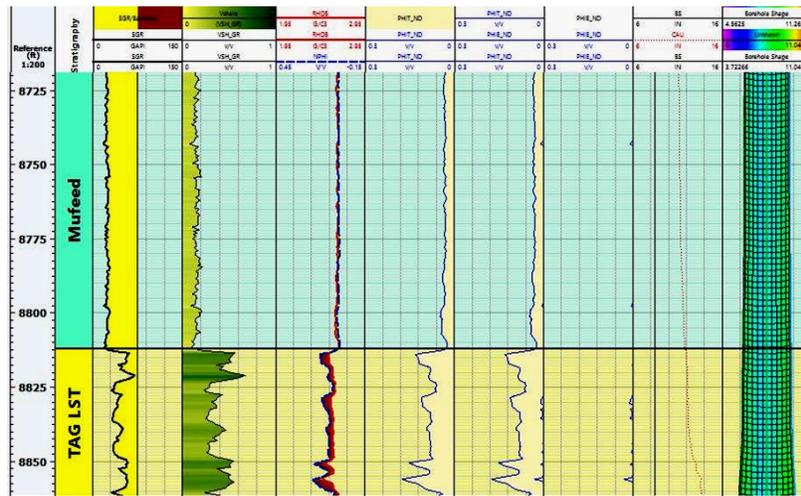


Fig (6) Total Porosity in Tagrift Fm. and Lower Muffed Fm. from Density and Neutron logs which in track Four in well V1-51.

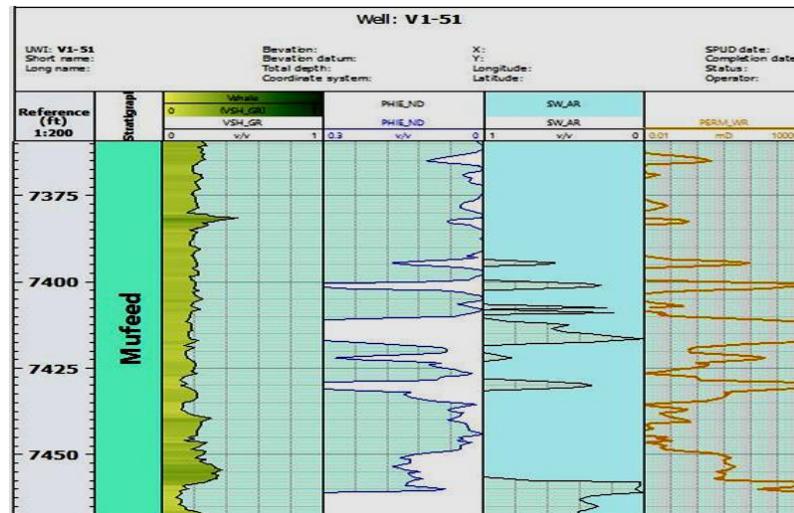


Fig (7) Calculated Permeability log from Water Saturation and Effective porosity in Muffed Formation in Well V1-51

3. Results and Discussion

It is An immediate one-dimensional model of acoustic vitality voyaging through the layers of the world. The engineered seismogram may be created by convolving those reflectivity inferred from digitized acoustic Also thickness logs for the wavelet determined starting with seismic information. Toward analyzing marker beds or different connection focuses picked with respect to great logs with significant reflections on the seismic section, interpretations of the information might be progressed. In this study, there would no thickness logs In this way the checkshot about great O1-51 used to discover the two manner chance (TWT) of the topsail of the intriguing formations Similarly as On figure 3. 2 then contrasted with the seismic segment number(XLine 200). Fig (8). Manual picking may be translating horizons looking into lines, cross-lines, occasion when slices, What's more traverses Toward hand. This may be those the greater part acquainted method. It may be also, Toward far, those any rate as productive Skyline elucidation system As far as mediator period Furthermore exertion. Same time translating manually, the mediator may be searching for some level for neighborhood coherence in the information What's more nearby similitude of character should recognize those occasion to make picked. To this data, 5 Horizons were picked done entire the zone beginning from the area about great V1-51 should whatever remains of the territory. These horizons from

top banana on bottom; highest point Tagrift limestone, Main Rachmat, top banana Bahi, highest point Volcanics and the highest priority on the cellar. Fig (9). The initial focus from claiming seismic information understanding will be to process structure two best approach the long run (TWT) maps to top banana Tagriftlimestone, top banana Rachmat, after that utilizing those comparison that concentrated from the relationship the middle of TWT and Z quality Fig (10) for the formations to change over all TWT maps will profundity maps (Fig. 11 What's more 12). A point by point 3d model for Nafoora oil Fig (13) need been constructed Eventually Tom's perusing those combination for seismic Also great logs. Information joining might have been encouraged Toward those PetrelTM, Schlumberger's supply demonstrating programming. The coordinated model need been used to help magic operational Furthermore supply advancement choices. The cross-sections Fig (14) committed starting with the 3d supply model done a significant number directions of the contemplate area, demonstrate the parallel and verthandi development of the separate horizons and their thickness including faults Also folds.

From seismic information translation that is coating the range of the contemplate prompted identikit that those region need been tossed in the southwest Some piece Furthermore northwest Some piece.

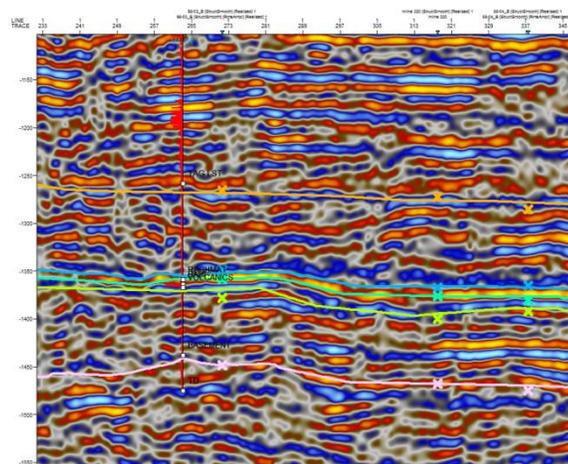


Fig (8) Well V1-51 tying with Seismic line (XLine200)

Because of WNW-ESE major strike-slip faults in the south and N-S fault in the north respectively. this throw is about 200 feet at the level of Tagrift and Rachmat formations and increases directionally with increasing the depth until reach to 1000 feet at the level of Volanics and Top of the basement.

This obtained structure gives us an expected to the new future drilling wells where it should be between

the two WNW-ESE major faults in the south and on the right side (up throw) of the N-S fault found in the north of the Nafoora oil field.

In Well V1-51, the effective porosity log and water saturation log used to calculate the permeability in Rachmat and Tagrift limestone formations which will be about 8.8 millidarcy. The histogram analysis for volume of shale in Rachmat

and Tagrift formation appear that the percent of Vsh in Rachmat Formation is 29 % and in Tagrift 38%

while the effective porosity is 18% and 13 % respectively

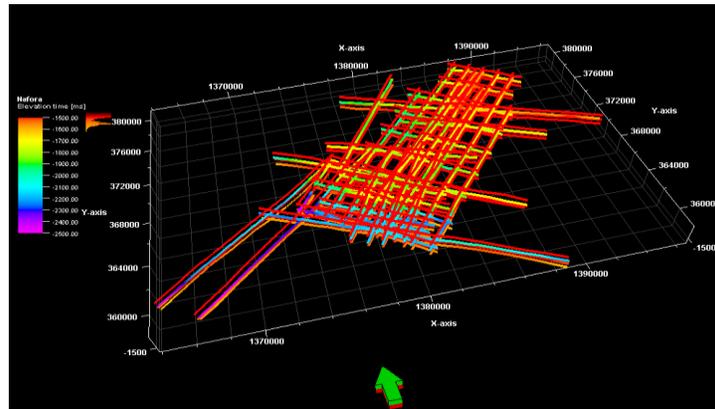


Fig (9) 5 Horizons Picking from top to bottom (top Tagrift limestone, top Rachmat, top Bahi, top Volcanics, and top basement)

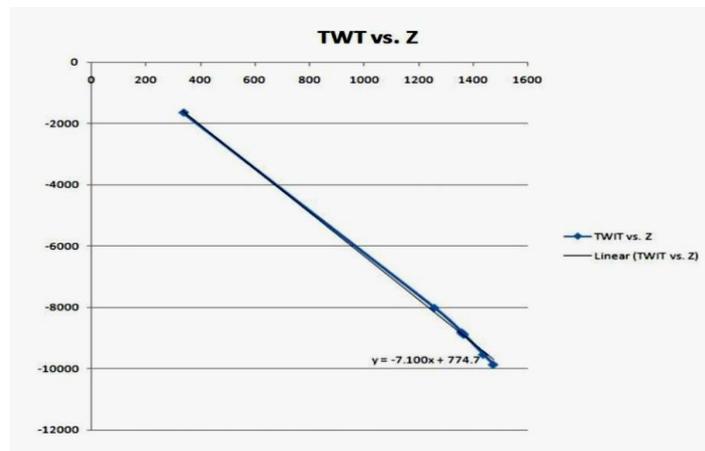


Fig (10) The relation between TWT and Z value and the resulted linear equation in Well V1-51

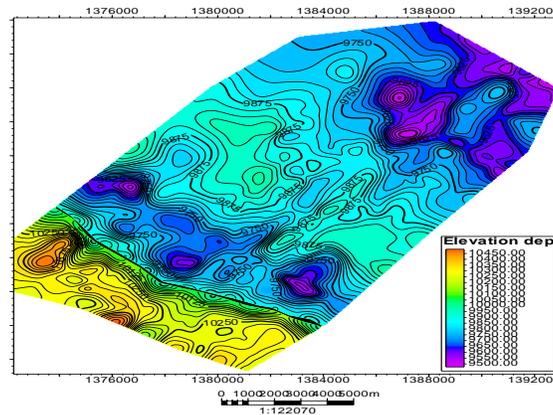


Fig (11) Depth Map of Tag rift limestone Formation

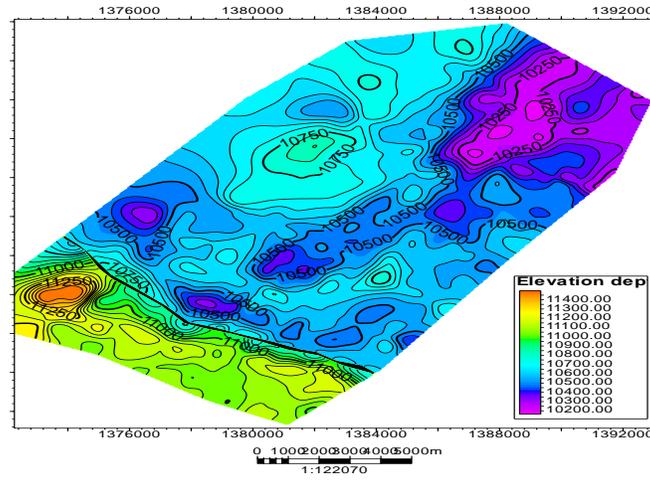


Fig (12) Depth Map of Rachmat Formation

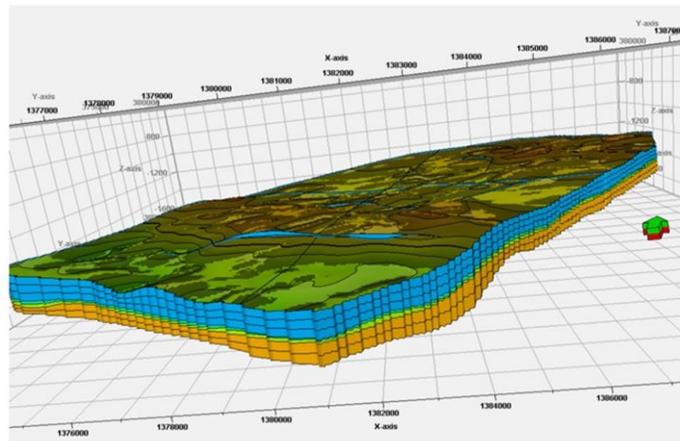


Fig (13) 3D Structure Model of the Nafoora oil field

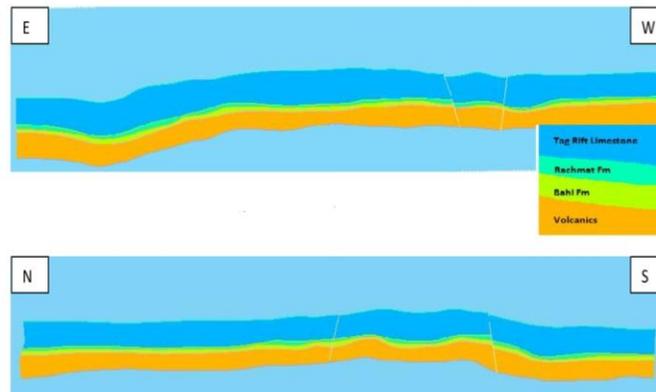


Fig (14) E-W and N-S cross-sections through the 3D Structure Model

5. Conclusion

The two WNW-ESE major strike-slip faults in the south of the field were resulted from the sheer force in direction of E-W and represent the key control for all faults in the area where the other N-S faults represent a results to this force and movement of these faults. In the reservoir of the area which is TAG Rift Limestone very rich with hydrocarbon with effective porosity 13% while the volume of shale is 38% and this is very low percent. The area hasn't complex structure and near to the surface of about 8000 ft. which makes it easy to produce.

6. Acknowledgement

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