The Impact of Paleogene-Neogene Tectonic Evolution on Oil-Gas Exploration: The Case of Eastern Liaoning Province

Hao HUANG [*,1], Tagen DAI [1] , Anyu JING [2]

[1.] *School of Geology and lnfo-Physics,* Central South University, Hunan Province, 410083, P.R. China
[2.] Geological Research Institute, Shengli Oilfield of Sinopoec, Shandong Province, 257015, P.R. China

***Abstract* - We study Quercus liaotungensis oil and gas exploration prospect in the east of Liaoning province using a combination of geological and geophysical methods. We analyze the relationship between structures and oil-gas, the results show that: i) the area Paleogene-Neogene has experienced three major changes in structure, developed multiple stages, multi level of angular unconformity surface, intense tectonic movements, formed mainly of strike-slip faults associated structure, ii) it has clarified the sealing of strike-slip faults at multiple stages, which features a segment of the space and control of the formation of the 3 types of: tectonics, stratigraphy and lithology in the reservoir, iii) the area has three types of oil and gas reservoirs: a) the oil reservoir in Shengshun well block represented by Guanxia section and Dongying group, b) the stratigraphic onlap oil reservoir represented by Shengshun100 of Dongying group, and c) the lithologic reservoir represented by Shunsheng2 well block in Minghuazhen group.**

Keywords - Tectonic evolution, The Bohai Sea area, Oil and gas reservoir, Sealing, Strike-slip faults.

I. INTRODUCTION

Eastern of Liaoning province exploration area, is mainly located in Fig.1, the Central Bohai gulf depression, in Liaodong bay depression and Jiaoliao uplift of the Tanlu fault zone, affected by the change of regional stress field, the direction of Tanlu fault has multiple stages, activity characteristics, cause complicated tectonic style, formation in residue, less research materials at the same time, not systematically explained the relationship between structure and oil and gas[1,2]. The paper bases on the research results as a guide, by combining Jing Zhen, synthesis and analysis of geological tests combined, a combination of research and well placement, the paper based on eastern of Liaoning province area geological evolution history and structural style of research[3], systematic analysis of the transportation system, accumulation mode of accumulation and point out the direction for the further exploration of the area[4,5].

Bohai bay basin is China's major petroliferous basin in the eastern part of China, it is located in North-Central of North China, the two sides of the border are respectively the Tan-Lu fault zone which the trend is NNE and the Taihang Piedmont fault zone[6,7]. The north and south sides respectively, from east to west is Qihe river-Guangrao arc fault zone and Changli fault zone, the north and south sides of the basin is narrow, the central is wide, which is generally presented a diamond. Including the North China plain, the Bohai bay area and the lower Liaohe River plain, the basin area is 20×104km2, within the continental meso-Cenozoic faulted-depression basins. Basal crystalline bedrock, sedimentary cover thickness 3~10 km (Li Desheng,1982). Bohai bay basin is belongs to the continental faulted-depression in Cenozoic basins, the tectonic line can be divided into the western strike-slip tectonic belt, central pull-apart tectonic region, strike-slip tectonic belt in the east, three depressions district(Hou Guiting etc,1998)[8].

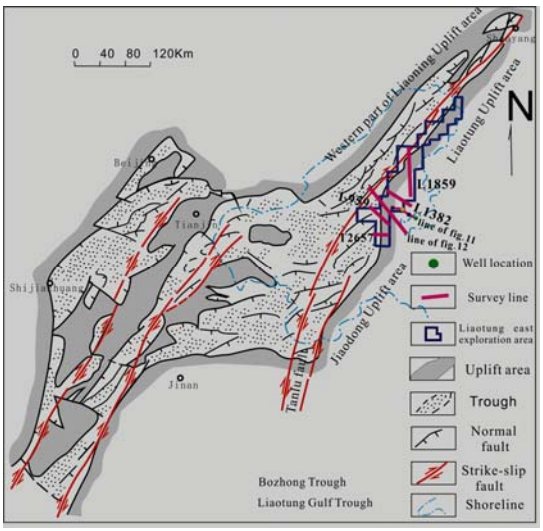

Fig. (1). Simplified geological map of Eastern Liaodong explosion region, Bohaiwan Basin

Eastern of Liaoning province exploration area is located in northeastern of the Bohai bay basin, regional structure is located in the eastern of the Bozhong depression, the northeast of Miaoxi bulge, and the western margin of Yingkou uplift, the exploration area is 5331.365 km2, the depth of water is general 0 ~ 30 m. Regional data show that Liaodong area adjacent to oil-rich sag oil

source, there may be a large anticline and stratigraphic traps, Paleogene and Neogene, and three sets of reservoir-Cap assemblages and Late Cretaceous, with a broad exploration prospects.

II. THE TECTONIC CHARACTERISTICS AND EVOLUTION

A. Tectonic Characteristics

The eastern of Liaoning province area regional structure is located in Bozhong depression, the lower Liaohe river depression and the Jiao-Liao-swollen joints, which is belong to the depression basin of marginal tectonic belt in West slope. Development of the regional unconformity surface, there is a regional unconformity between Dongying group and Shasi-Kongdian group (Figure 2), Dongying group and Guantao group, Ming town and the quaternary, it reflects that it has experienced three times of intense tectonic movements, missing the upper part formation of the Shahejie group.

stratum			lithology
Cainozoic	Quaternary System	Pingyuan Group	sand-shale interbed
	Neogene	Ming huazhen Group	Thick sandstone ,conglomeratic sandstone, fine sandstone with red and green mudstone on the bottom
		the upper member of Guantao Group	Thick thin sandstone with thin layer of red, green mudstone, sandstone content is high, the top of the thick layer of mudstone
		The lower member of Guantao Group	Fine sandstone, fine sandstone and mudstone are frequent mutual layers, which are thin sandstone with thick mudstone. The whole bottom sandstone is thin, the thickness is thin, and the mudstone is increased.
	Paleogene	Dongying Group	pebbly sandstone, coarse sandstone, fine sandstone in the lower part, thick mudstone and thin sandstonein the upper part
		Shayi member of Shahejie Group	interbeds of Grey brown mudstone , Tan carbonaceous shale andLight gray fine-grained sandstone, calcareous sandstone , siltstone in different thickness
		Shasi member of shahejie Group - Kongdian Group	brownish red, light grey mudstone, conglomeratic mudstone is given priority to, clip a thin layer mottled conglomerate, shallow gray conglomeratic sandstone and conglomeratic grit and light grey with cream mudstone, dark gray, tuffaceous shalein the upper part.Interbeds ofLight gray mudstone, dolomite mudstone andLight gray, grayish yellow argillaceous dolomite in different thickness in the upper part.The local are black carbonaceous mudstone and coal seam, with purple red mudstone layer.
Proterozoic		middle-upper proterozoic erathem	Gray, light gray, pale yellow limestone, marl, argillaceous limestone and black, gray green, gray brown, green and gray diabase, gabbro, gray, gray green, with purple red flash tonalitic porphyrite clip dark gray mudstone and gray green, gray black metamorphic rocks

Fig. (2). Stratum column in study area

Neotectonic movement in the region is evident at the same time, influenced by Tanlu fault take slippery activity, large fault dip angle, small head; The section is shaped flower structure, negative flower structure, etc. Minghua town group and above strata, the secondary fault development. Paleogene-Neogene in the Liaodong area are mainly North-East, North-North East, North West and East to four groups of faults. According to nature, activity and fault activity characteristics such as time, roughly divided into the following 4 types (Figure 3):

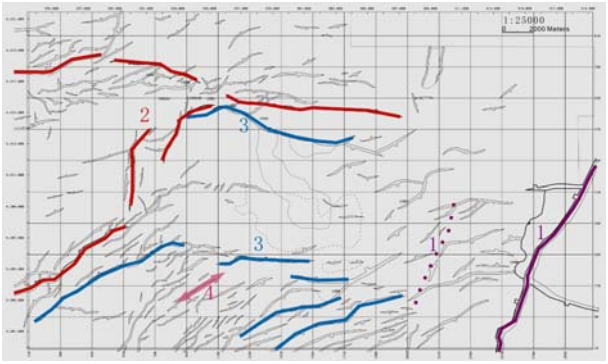

Fig. (3). Eastern of Liaoning province exploration area at the bottom of the Guanxia lower segment structure diagram

Paleogene of Shasi- Kongdian group is very active, neogene stop activities (figure 3, no. 1 fault), which belongs to the one of Tanlu fault, it controls the sedimentary Kongdian group-Shasi segment in the exploration area, fault fall plate deposition was covered thick in Kongdian group -Shasi segment, the maximum thickness is about 1600 m.Shunsheng6 fault belongs to this kind of fault (Fig. 4 a).

From palaeogene to neogene ,the strike-slip faults is continuously active, the fault is distant, activity duration is long (Fig. 4 b), as a result of the action of Tanlu fault zone right-lateral strike-slip stress field, it formed the north east, north west of the two groups of conjugate strike-slip faults. The northeast trend strike-slip faults controls deposit, the tertiary Shasi-Kongdian is active, the biggest drop height can be more than 1000 m. The fault tends west, controls the tertiary sedimentary in exploration area. North-north-east toward Miaoxi bulge and north-west-west Shunsheng 1 fault is such kind. Miaoxi bulge west fault Tanlu fault is the other one, tertiary to neogene is a continuous activity, it controls the paleogene sedimentary, fault decrease palaeogene formation, it is thick, and the raised disc is only reserved in Shasi-Kongdian and Dongying group the Shasi-Kongdian group is thicker, the Dongying group is thinner. The fault plane is "S" glyph distribution, a shovel shaped profile. North-west Shenshun1 fault cannot control deposition the deposition (Figure 4).

In the influence of dextral strike-slip, since the Paleogene the Tan-Lu fault zone formed North-East, North-West and two sets of conjugate strike-slip faults associated faults, This fault extends farther, since the late palaeogene it has been active continuously, the activity of Dongying group is stronger(figure 4C), and guantao group

is weaker, generally, the drop height is between 50-100m, this type of fault is developed well in the slope, forming slopes fault step zone, it formed the down scroll bar structure. The third fault in three dimensional zone which the direction is the North West, North East and East is this type of fault (Figure 4).

New tectonic movement (movement in the Bohai Sea) and the Tan-Lu fault zone in the neogene-nowadays dextral strike-slip strong tectonic activity formed strike-slip fault (figure 4d). These breaks are mainly in the direction of North-East and are arranged in Echelon, also a little North-West trending fault, the 4th fault in Figure 2 is such fault. Faults often do not extend too far and connected each other. Shallow faults in these sections are often composed of paleogene syndepositional faults in Y-shaped or formed like flower structure, which belongs to the later activities of secondary faults. This type of fault are usually small, the width is between the 20-50m, but it have been actived to the end of Minghuazhen, even today. In the influence of strike-slip fault, it is extended or compressed by the strike-slip fault in different parts of respectively, the local stratigraphy is thickened and thinned, local stratigraphic occurred mutations, formed local angle unconformities, and we can see the obvious truncation. Among them, the North-East trend fault system is the major fault systems in the slope area, are arranged in Echelon on the plane. The trend of the NE-trending faults is diagonal or orthogonal with construction line, it can form small fault nose-shaped in two local faults. Under the influence of dextral strike-slip in three dimensional region of the North, the South, the trend developed a group of North-West fault zone, intersects with North-East trending faults, it appears Y-shaped in the section. North East and North West to the intersection of faults, forming a series of broken noses, broken blocks, are favorable for hydrocarbon accumulation in places. The faults of North-East and North-West are intersected, forming a series of fault noses, broken blocks, are favorable for hydrocarbon accumulation in places.

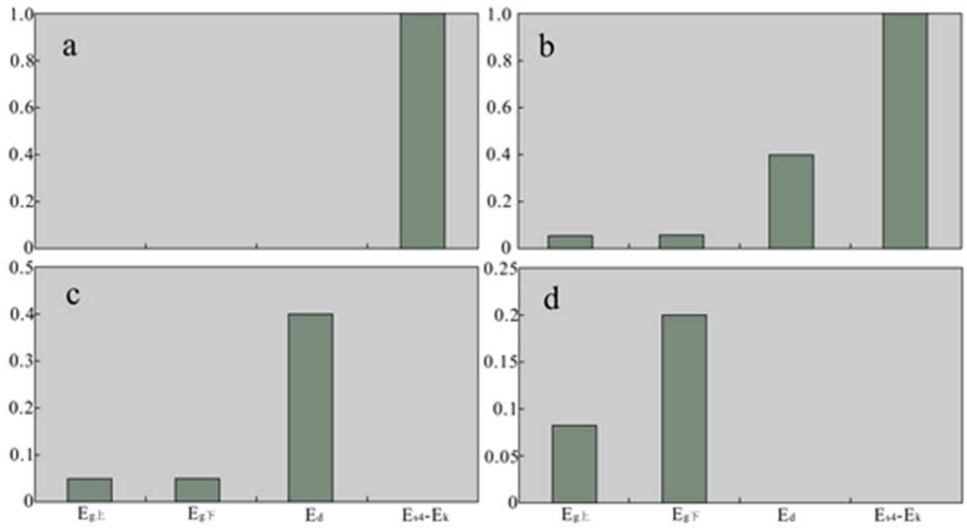

Fig. (4).Growth index of Tertiary faults of Eastern of Liaoning province area

B. Tectonic style

Under the control and influence of the Tan-Lu fault zone, the Bohai Bay area of Cenozoic tectonic stress field is characterized by dextral torsional characteristics (Figure 5), thereby it controls the formation and development of the Shengshun oil fields. Since the Oligocene, the Tan-Lu fault zone dominated by dextral, but it's intensity has obvious stage. From oligocene and pliocene to nowadays, the Tan-Lu fault's dextral strike-slip activity is strong, and Miocene tanlu fault activity is significantly weaker. Under the control of the Tanlu fault activities, the fault of Liao dongdong exploration area is formed in two periods, and early or before the oligocene, it formed two groups, which are NNE fault and NWW fault, the NNE fault is parallel to the major fault of Tanlu fault, it is synthetic strike-slip fault, the NWW fault is the reversed strike-slip faults which is vertical to Tanlu main fault activity. The faults formed during this scale is relatively larger, the cutting is deeper, they often cut into the basement, the inheritance of this type of fault is good, and has the characteristics of long-term development. From Pliocene to nowadays, the influence of dextral strike-slip activity in this period, it mainly formed small size Shengshun fault system, they are in Echelon shape on the plane, a flower-shaped in profile structures, half flower structure, pinnately arranged, combination type.

1) Slip style: Strike-slip tectonics refers to the various structural combination of formation under the effect of the horizontal shear stress, including the strike-slip faults and

its associated structure. Influenced by Tanlu strike-slip faults, the research area of strike-slip tectonic characteristics is very obvious. They are mainly as follows: (1) the fault is steep, the drop is small and the seismic identification is difficult. (2) On the plane, the fault is obvious aligned in Echelon, there are 4 major strike-slips in the three dimensional area: In north and south of three-dimensional area are mainly the sinistral in the direction of NWW-SEE ; In west and east of the three dimensional district are mainly dextral in the direction of NNE-SSW , consistent with the characteristics of Tanlu

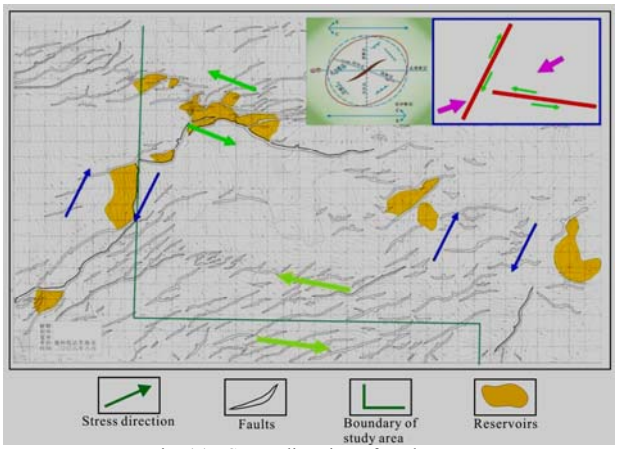

Fig. (5) . Stress direction of study area

strike-slip; In the Central, Western and North-Eastern regions of study area, the strike-slip activity is weaker relatively, it is characterized by extensional features under strike-slip structures- (3). In profile, the fault appears negative flower structure or half flower structure, which is formed under torsional stress products.

Profile:

1-a) Negative flower structure and half flower structure: Under the influence of strike-slip, the common major fault in profile is deep narrowing and steep, and spread a flower structure in shallow.

On the whole it is a extensional structure area environment in the Bohai Bay basin, and the research area overlays the Tanlu strike-slip, therefore, it mainly appears torsional stress environment in the study area, forming a flower structure (Figure 6,7).

1-b) Cabbage-faults: In addition to the usual typical flower structure in the research area, there also developed a kind of more complex "cabbage"-faults which composed of normal faults (Figure 8). They is no obvious cut deep into major fault, it is often composed of multiple flower structure or half flower together. The fault slip is small, the number is big and the cutting layer of faul is shallow. It's formation may be associated with superposition of multi-stage strike-slip activity, namely the results is the two strike-slip activity of the paleogene and neotectonic period overlay together.

1-c) Parallel-steep faults: The dip angle of fault is directly related to it's properties, the maximum inclination of the normal faults which formed under extensional effect is 60 °-70 °, the angle of the thrust faults which formed under compression is usually 40 °-50 ° or below, and strike-slip faults dip is often large (>70). In the eastern of the study area there developed a large number of parallel steep faults which strike-slip tectonic style is obvious. These faults on the 3d seismic reflection is littery, sometimes they appear mixed and disorderly reflection band, the slip is not obvious, but the formation of both sides of the fault occurrence has obvious changes (figure 9), they are the obvious strike-slip faults.

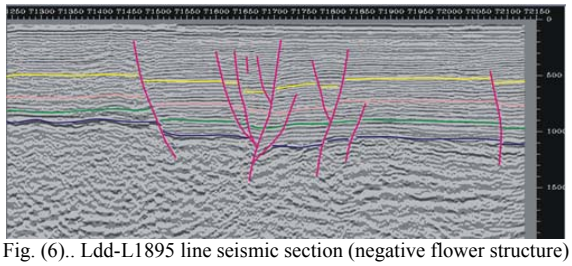
Fig. (6).. Ldd-L1895 line seismic section (negative flower structure)

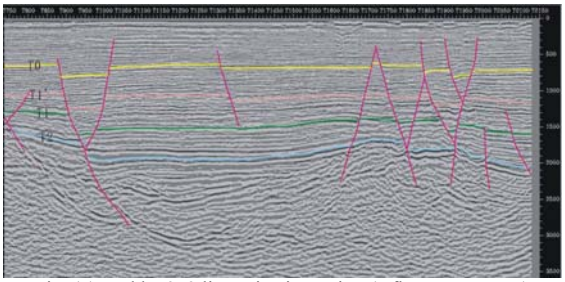
Fig. (7).. Ldd-L959 line seismic section (a flower structure)

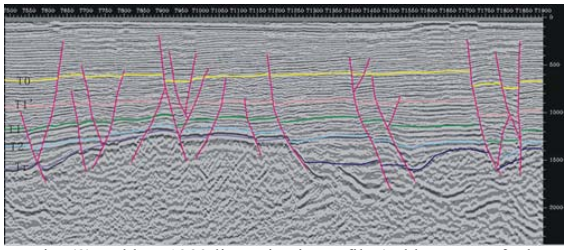
Fig. (8). Ldd - L1382 line seismic profile (cabbage type fault combination, and the "Y" type fault combination)

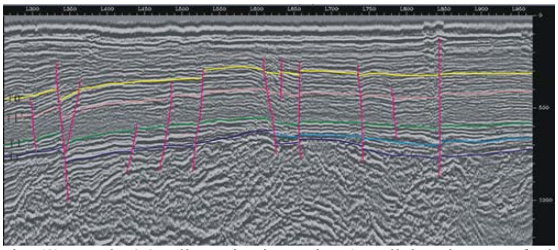
Fig. (9). Nssd T2657 line seismic section (parallel to the steep fault combination)

On the plane, strike-slip effect is usually in the shape of strip, along the strike-slip belt it formed echelon fault combination, a single strike-slip fault is derived under the action of local stress field, a single axis of normal fault and strike-slip belt of sharp angle indicates the direction for this dish. There developed two significant sets of slip bands in the study area (Figure 2), one group the trend is NNE-SSW which parallel with the Tan-Lu fault and its faults are arranged in the right, they are mainly developed in the west of the study area; The other group the trend is NWW - SEE, it's normal fault are arranged on the left, they are mainly in the north and south on both sides in the study area. The two direction of strike-slip belt formed conjugate shear zone which dated from the neogene under compression stress field and in the direction of NEE-SWW.

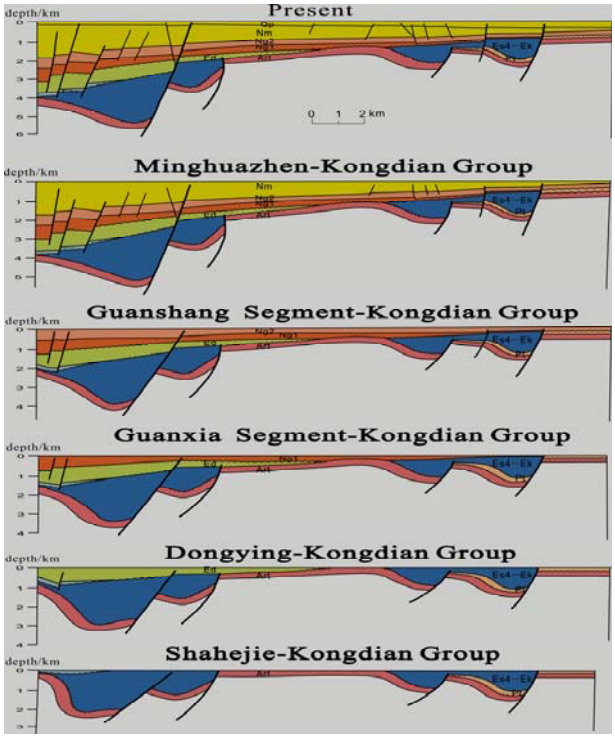

Fig. (10). structure in the middle of Bohai development section

2) En Echelon Crack Fold: Along the twisting En Echelon folds is the most important and most hydrocarbon structure. In the anticline formed half anticline or anticline traps, Miaoxi bulge is this kind. On the slope belt, the upper and lower of plate wrench fault can form block, fault nose trap, such as Shengshun1 fault block.

C. A Tectonic Evolution

On regional tectonic evolution of eastern of Liaoning province exploration area analysis results show that (figure 8), during eastern of Liaoning province exploration area of paleogene system - neogene tectonic evolution, there are significant differences in each period, based on study of fault and the tectonic style of the area, the area of paleogene and neogene tectonic movement can be divided into the following 4 periods:

Kongdian-Shasi period, it developed on the basis of Mesozoic tectonics in geomorphology in the paleogene and neogene, it belongs to filling gap sedimentary stage, Tanlu fault branch disk declined depositional Kongdian-Shasi formation, the thick sand stratum slope is bigger, it is angular unconformity with the underlying pre-neogene strata contact formations from eastern to central overlapping, thin wings and thick in the middle. The east is given priority to with overlap, and has few faults. In the later period of Shasi under the influence of regional tectonics, the area overall uplift, being subjected to erosion, and the overburden formed an angular unconformity contact.

Shasan-Dongying period, during the strong fault depression period in the Bohai bay basin, it deposits the thick Shasan-Dongying strata, and the sedimentary center gradually transferred from the south to the north to the Bohai bay in the sag. Before Shayi deposit period it appeared residual distribution, and the late Dongying, it affected by the tectonic movement of Bohai bay, eastern of Liaoning province exploration area regional uplift and denudated,formed and overlying strata show angle unconformity contacting relationship. Western fault activity is intense, controlled deposition of Shasan formation to Dongying group, the east fault activity is weak, the stratigraphic layers overlap over the pre-Cenozoic basement.

Guantao-Minghuazhen period, in the influence of Tanlu fracture dextral strike-slip movement and the new tectonic movement, the eastern of Liaoning province exploration area formed tectonic framework which mainly associated by strike-slip faults structure. On the plane, it mainly appears two groups that East to West and North to North East, on the section, it appears a typical flower structures or like flower structure and "Y"-shaped structure formation, the erosion evident lateral is thinning, the formation transverse become thinning, the denudation is obvious. Particularly in the effects of strike-slip fault, along the strike in paleogene and neogene it form a number of valleys, in the Valley of wing formation truncated phenomena is obvious, we can see formation uncomfortably in local areas clearly.

On regional tectonic evolution of eastern of Liaoning province exploration area analysis results show that (figure 10) Nowadays, on the influence of the Tanlu fracture dextral strike-slip movement and the new tectonic movement, the eastern of Liaoning province exploration area inherited the structure of tectonic framework which is mainly associated with strike-slip faults, but it has had the tectonic inversion, strata horizontal overlap becomes thinning from east to west.

There is a direct link among eastern of Liaoning province exploration area formation and basin evolution and the structure of the Tanlu fault zone Cenozoic dextral strike-slip activities. In the tanlu fault zone of eastern of Liaoning province exploration area, in the influence of the superposition of multiphase tectonic movement, it formed the north-east intensive tectonic framework. Tanlu fault activity is the power source of the formation and development of Bohai sea structure, it has tremendous impact on Bohai Sea tectonic and geological evolution. Oligocene, Tanlu fault show the dextral strike-slip activity, the Bohai bay basin is in chasmic stage, in the dynamics mechanism of right-lateral strike-slip pull-apart basin formation, it formed a NNE-trending faults, and conjugated with the NWW trending faults. From pliocene to today, as the Tanlu fault right strike-slip activity increased, and on the basis of the early formation of the fault, it derived a series of small-scale NE and nearly EW to secondary faults, which was on the plane echelon arrangement, on the profile it appears flower shaped structure, half flower, feather arrangement, such as combined type, it reflects the result of right strike-slip fault activity.

III. RELATIONSHIP BETWEEN TECTONIC EVOLUTION AND OIL-GAS

A. Relationship between structure and carrier system

Whether it fits the fault activity and hydrocarbon expulsion period is the premise of oil and gas could enter the thin conducting system, fault and unconformity surface, the effectiveness of the conducting layer configuration is the key to the hydrocarbon migration smooth or not. eastern of Liaoning province exploration area mainly has the following 3 types of carrier system.

(1) Sandstone transport conductors: Sand body can be either as oil and gas reservoir space, and can be used as an oil-gas migration channel; it is the most basic transportation systems. The role of sand-size transport system in transporting oil-gas is mainly reflected in the distribution of sand bodies in the plane's range, the thickness of the sand, sand ratio and porosity and permeability, and so on.

In this area, the thickness of stratum in Shahejie group and Kongdian group is thinner (Table 1), the top has erosion phenomenon, only Shengshun5 well has a certain thickness of the Shahejie formation deposition, basically it has no Shahejie formation deposition on the slope, therefore, the sand body of Shahejie group and Kongdian group formation cannot be regional conductor.

In this area Dongying group is half deep lake - shore shallow lacustrine delta deposits, it is mainly the delta plain and front facies,the distribution of the sand body is mainly along the main river channel ,the sand body distribution range is not big, seen from the area the sand mud is lower, from west to east along the exploratory well Shunsheng 5, 4, 100, 1, 2, 6, 8 to Shunsheng6, sand ratio is followed by 35%, 29.5%, 40.53%, 33.3%, 27.12%, 33%, the veriation presents from less to more to the less, only the sandstone percentage of Shunsheng1 oil well and Shunsheng 100 oil well is bigger, therefore, in this area sand bodies of Dongying group is very difficult to become a regional transport conductor

In the region, the lower Minghuazhen group and the upper Guanshang section, it develope the thick massive braid-shaped river sandbody, the thickness of single-layer on the Guanshang section is 90~180m, the sand ratio is more than 70%, good connectivity (Overlay rates 75%),it is a good transport layer, and it could constitute the regional transmission conductors.

TABLE 1.AMOUNT OF ORGANIC MATTERS AND EVALUATION OF DIFFERENT HYDROCARBON SOURCE ROCKS FROM EASTERN LIAODONG EXPLORATION REGION

Position & name of well	Guanshang section			Guanxia section			Dongying group			Shayi section		
	Total thick-ness（m）	Sand thick-ness（m）	Storage %	Total thick-ness（m）	Sand thick-ness (m)	Storage %	Total thick-ness (m)	Sand thick-ness (m)	Storage %	Total thick-ness（m）	Sand Thick-ness（m）	Storage %
ShengShun 0	230	186.3	79.57	271	102	37.64	152	61.6	40.53			
ShengShun 1	208	128	61.70	260	104	40.00	108	36	33.30			
ShengShun 2	199	98	49.25	248	126	50.81	98	26.58	27.12			
ShengShun 4	221.5	183.5	82.8	298.5	113	37.9	171	50.5	29.5			
ShengShun 5	270	202.5	75	269.5	108.5	40.3	230	80.5	35	41.5	15.5	37.3
ShengShun 6	136	93	68.4									
ShengShun 8	189.5	147.5	77.8	67.5	26	38.5	49	16	33			

2) Fracture transmission conductors: Oil and gas migration channel is the key to the formation of two source-reservoir-Cap system, which is the under reservoir and new old reservoir. Due to long-term activities in the area of basement faults in the Paleogene-Neogene deposits activities are still strong, some even in

Minghuazhen group is still active, and this period is an important stage of hydrocarbon source rocks in the area. These faults not only controls the drop source development of depression, and with the rising plate connected to a buried-Hill drape structural and other traps, then it becomes a source of major active faults. Due to the shallow is affected by the neotectonic movement in the area, numerous shallow faults have been developed, these late early fault and early basement faults configurate together, constitutes the longitudinal channel of oil and gas migration. Shunsheng 1 well in Dongying group and Guanxia section layer show that the longth of oil and gas well is 454 m (975 ~ 1429.2 m), commercial oil flow of Dongying group and Guanxia section is 80.3 t, 75.5 t in the test, it confirms that the fault network are the main migration channels.

3) Unconformity transport conductor: There have been developted more regional unconformity surface in the area, such as the unconformity surface between paleogene and neogene, the unconformity surface between Shasi-Kongdian section and Dongying group, the unconformity surface between Dongying group and Guantao group, the unconformity surface extension is wide, the area is large, the continuous time is long, after it was cut by the fault, it could link the up and down, form a good channel for vertical hydrocarbon migration. The biggest well hole porosity in the upper part of Shasi-Kongdian group in Shunsheng1 well is up to 7.05%, the permeability is 0.963×10-3μm2, the oil patch of logging see heavy oil shows that it is 4 m / 4 layers, the biggest well hole porosity in1316-1352m of Shasi-Kongdian group in Shengshun 100 well is 6.4%, the permeability is 1.02×10-3μm2, logging see heavy staining showed 36.0 m / 3 layers, transverse conducting further confirmed that the oil and gas along unconformity surface, and the water of the test on the top of Shunsheng8 Well in the neoproterozoic is about 46m3/d , it shows that unconformity surface, especially the bedrock of unconformity are the main conductor (figure 11).

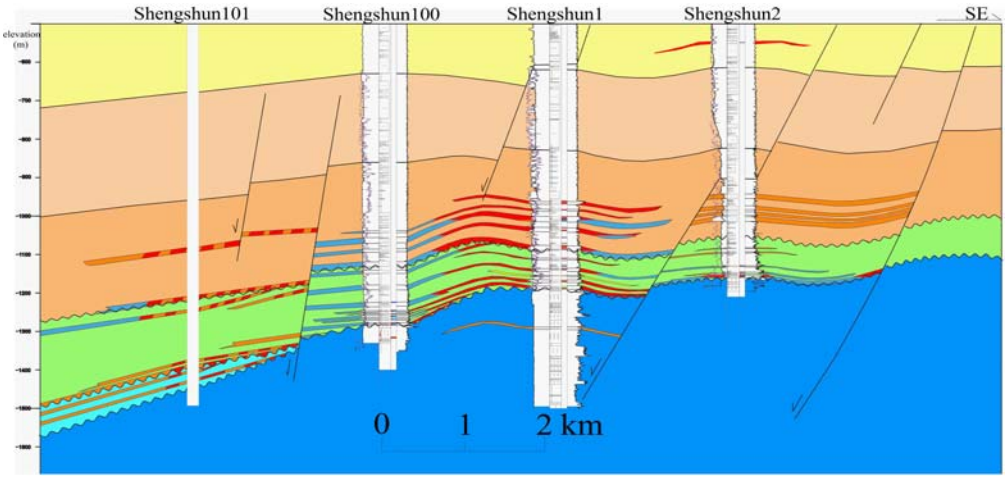

Fig. (11) .Shengshun0- 2 east-west oil reservoir section of eastern of Liaoning province exploration area

Due to the structural belt tectonic style is different, and the relationship with hydrocarbon generation spot is different, different structural belt of conducting system combination is also different. Fracture slope of West sag in the down of the Shahejie formation, sand bodies in Dongying formation direct contact with hydrocarbon source rocks, oil and gas does not need to go through long distance migration, right into the trap-forming;

The sand body of the Shahejie formation and Dongying group which in west sub-sag downdropped block belt in fracture slope break belt direct contact with the hydrocarbon source rock, oil and gas don't required long distance migration, it can directly hide into the trap; For the belt of neogene reservoir, it can provide sources of oil and gas vertical migration through the basement fault. So the combination of carrier system is the simplest. The tectonic belt of strike-slip fault zone in central developes neogene, Dongying formation of broken noses, broken structure, and central zone of Dongying formation in stratigraphic overlap traps, Shasi + Kongdian formation traps, the accumulation of these traps is depend on a variety of channels. Compare with the Jiyang depression, it is thought that meshwork-carpet type carrier may be the primary transport type. Oil-gas vertical migration along the basement faults, Delta sand bodies in Dongying formation in carpet-like reservoirs and carpet of fluvial facies of the neogene reservoir is in a lateral migration, and it configurate with the later fault in the neogene, then form a stereo transportation network. Eastern stratigraphic overlap structure zone are far away from oil source, there may be multiple layers of carrier systems in multiple layers overlap belt. The unconformity surfaces and neogene carpet-shaped reservoir is one of the important transportation systems.

From Shengshun1 reservoir section (figure 11), you can see that the development of eastern of Liaoning province exploration area has three types of reservoirs, namely the structure of the oil reservoir in Shengshun wellblock which is represented by Guanxia section and Dongying group, the stratigraphic onlap oil reservoir represented by Shengshun100 of Dongying group and the lithologic reservoir.represented by Shunsheng2 wellblock in Minghuazhen group.

B. Structure and reservoir-forming pattern

The eastern of Liaoning province exploration area is the sand body horizontal, integrated lateral and vertical ladder-accumulation mode (Figure 12). Oil-gas which generated from the Bodong depression migrate along thepaleogene sandstone unconformity surface, lateral migration of fault vertical migrate to neogene, new tectonic movement in neogene formed the secondry faults which is migrate in vertical direction, the sand body of the Guanxia section migrate lateral and accumulate into oil reservoir. The conducting of the fracture is good, the north-north-west direction is the predominant conducting direction, on the predominant conducting direction, updip direction at the fault structural trap (anticline, fault nose, etc.) and stratigraphic unconformity trap, lithologic trap is effective trap.

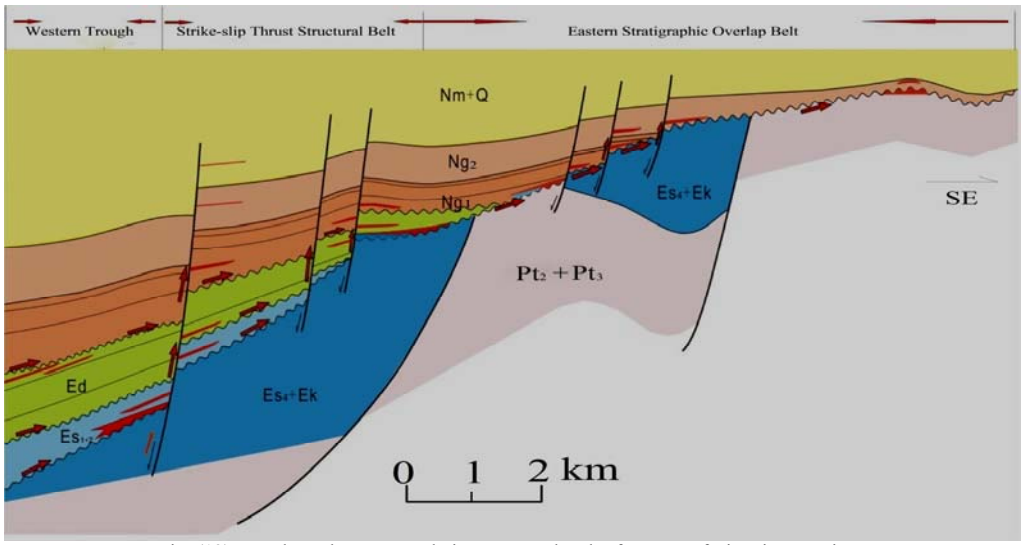

Fig. (12) . Hydrocarbon accumulation pattern sketch of eastern of Liaoning province

Influenced by Tanlu fault slippery activity, the development of the fault has the characteristics of "large dip Angle, divide the small", negative flower structure, the characteristics of strike-slip tectonic system appears en echelon arrangement on the plane section, the geological structure is complex. Controlled by structural and stratigraphic development features, the eastern of Liaoning province exploration area formed the strike-slip faults associated structure tectonic framework and stratigraphic overlap structure, it developed many fault blocks and fault nose structure trap and lithologic and stratigraphic trap. On the background of stratigraphic overlap, according to the structure characteristics of the southern part of eastern of Liaoning province three-dimensional exploration area division, it can be divided into sub-sag, strike-slip fault zone and stratigraphic overlap, sub-sag belt of the main developed paleogene gravel rock lithologic trap, paleogene and neogene fault nose and fault block, rolling anticline traps, etc; Strike-slip fault zone mainly developed block, broken nose, stratigraphic, unconformity trap types; stratigraphic horizons mainly developed stratigraphic overlap traps and drape Anticline traps, it also developed a small amount of fault, fault-block traps.

IV. CONCLUSIONS

Through the study of tectonic evolution in eastern of Liaoning province exploration area, systematically elaborated the relationship between structures and oil-gas in the area, and in order to point out the direction for further exploration, the obtained results are as follows:

1) Tertiary in Liao Dong exploration area has experienced three major changes in structure, developed a multi-phase, multi level of angular unconformity (There is regional unconformity between Dongying and Shasi-Kongdian formation, Dongying group and Guantao formation, Minghuazhen group and the quaternary system), tectonic movements is intense, it mainly formed strike-slip faults associated structure structure;

2) Clarified the sealing of strike-slip faults have the characteristic of stage on time, have the characteristic of

segment of the space, and permeable rock formations, unconformities constitute the stereo carrier networks, they control the formation of the 3 kinds of tectonics, stratigraphy, lithology oil reservoir, main controlling factors are different in different systems, and different types of oil and gas reservoirs.

3) Liaodongdong exploration area has developed three kind of reservoirs, namely Guanxia section of Shunsheng1 well drill, the oil reservoir which is represented by Dongying group, the stratigraphic overlap oil reservoir which is represented by Shunsheng100,and the lithologic oil reservoir which is represented by Minghuazhen group of Shunsheng2 well drill.

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