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The tectonic characteristics and evolution in Gulongnan region of Songliao basin

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Abstract: In this paper, the tectonic characteristics in Gulongnan region of Songliao basin were studied.The study area is divided into seven tectonic units. Fault intensive belt is NNW direction. In the northern area, the faults are tectonic genesis ,in the southern area,the faults are tectonic mixed with non-tectonic genesis.Fault activity show for polyphase. Based on the balanced section recovery, analyzed the tectonic evolution stages of the study area.

Keywords: *Gulongnan region ,Songliao basin,tectonic,tectonic evolution*

I. TECTONIC FRAMEWORK OF GULONGNAN REGION

Gulongnan region of Songliao basin is located in Zhaoyuan county ,the Daqing city of Heilongjiang Province China. Xinzhao and Aonan oil field is in the east direction of Gulongnan region,Nenjiang and Xinzhan oil field is in the southwest direction, Puxi oil field is in the north direction.This region is in south of Qijia-Gulong sag which is in north direction of Songliao basin.According to the fracture distribution and tectonic ups and downs characteristics,Gulongnan region can be divided into Yingtai nose-like structure,Xinzhao nose-like structure, Xinzhan nose-like structure, Aonan nose-like structure, Gulong syncline, Maoxing syncline and transition slope(figure1). The tectonic framework show cncave and convex alternately.

II. FAULT DEVELOPMENT CHARACTERISTICS AND FAULT ACTIVITY OF GULONGNAN REGION

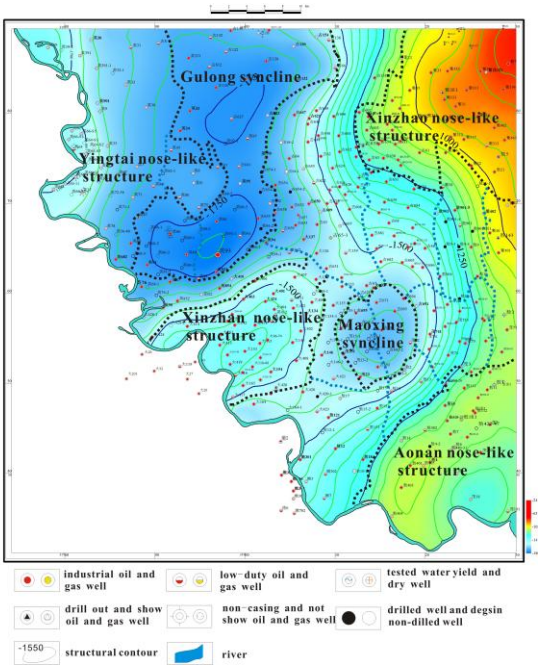

Fig.1. Tectonic framework of Gulongnan region.

2.1 Fault development characteristics in the study area

(1) NNW strike faults develop intensively in groups and belts.

Based on the distribution characteristics of fualt, can draw NNW and near SN direction of fault intensive zone in T11 interface. Fault form in section is characterized by base and rift tectonic style.Fault density in South is significantly higher than that of North, fault density in Qingshankou – Yaojia group is higher than that of Nenjiang group.

(2) In the northern area, the faults are tectonic genesis ,in the southern area,the faults are tectonic mixed with non-tectonic genesis.

Based on the statistics of faults strike and trend in the Yingtai three-dimesional area which is in the northern Gulongnan region,found that the faults are mainly NNW tendency (figure 2) and generally small,show typical tectonic genesis. It can be deduced that the study area was actived by NEE - SWW direction tensile stress in the end of Yaojia group.

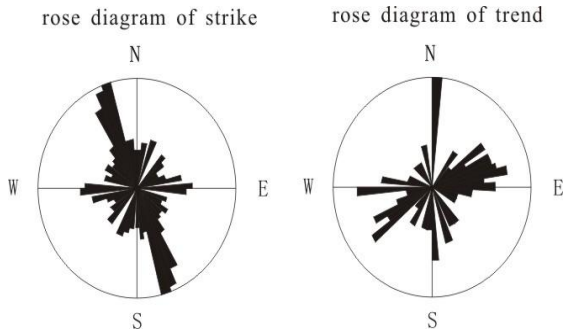

Fig. 2 Rose diagram of faults in interface T11 in Yingtai three-dimensional area.

Based on the statistics of fault strike and trend of the Maoxing three-dimensional area which is in the southern of Gulongnan region, found that the strike of faults are changeable and generally small (figure 3, figure 4).

The study suggests that the study area develop polygonal faults in the southern part.Polygonal fault is widely developed in marine sedimentary formation, but in recent years, study found that continental sedimentary basin can also develop polygonal fault.Polygonal fault generally has the following characteristics:strike of faults are changeable in plane; layer controlable in section;high angle normal fault;faults cross each other.And the sedimentary strata is mainly fine grained sediments.

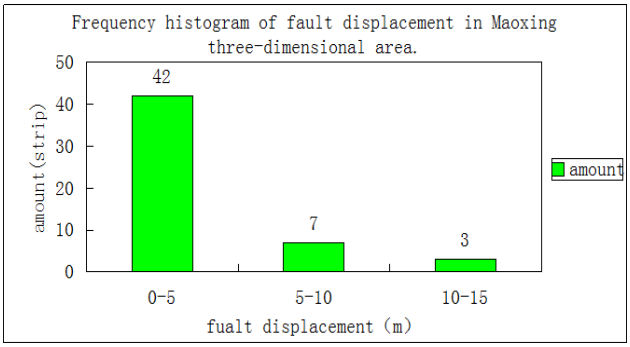

Fig.3. Frequency histogram of fault displacement in Maoxing three-dimensional area.

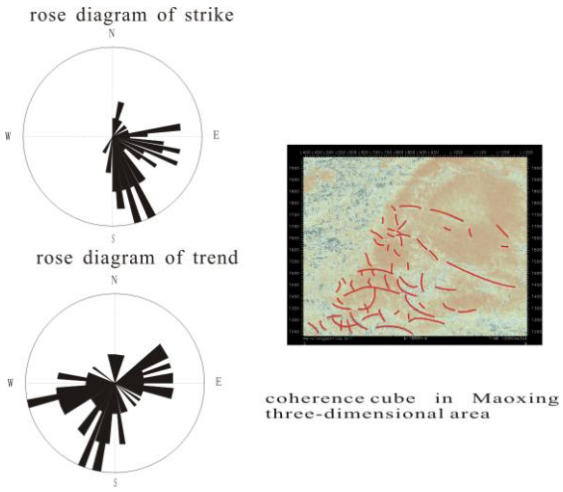

Fig.4. Faults characteristics in Maoxing three-dimensional area.

Its mechanism is believed to have the following kinds: density inversion effect; gravity slid or collapse of fine grained sediments in slopes ; episodic hydraulic fracture in overpressure mudstone layer; volume contraction function of rich mud sedimentary strata[1].

Study in three-dimensional seismic data suggests that some faults in southern area fit the characteristics of polygonal fault (figure5).In addition, Sanzhao sag which is adjacent to the study area,has been proved that polygonal faults are widely developed, the tectonic development and sedimentary environment are similar.

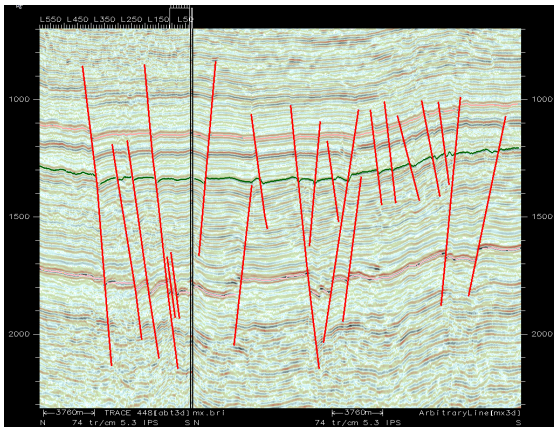

Fig.5. Development characteristics of polygonal faults and tectonic faults in the typical seismic section of Maoxing syncline.

2.2 multiphase fault activity

Based on the observation of the trans-formational characteristics from seismic section,it can be seen that trans-formational characteristics mainly have the following categories: Yaojia group –Nenjiang segment one and segment two faults (type T11 - T1 or T11); Qingshankou group –Nenjiang segment one and segment two faults (type T2 - T1) ; less number of Yaojia group - phase retrograde at the end of Nenjiang group faults (type T11 - T06); Qingshankou group –Nenjiang segment one and segment two –phase retrograde faults (type T2 - T06) (figure 6).

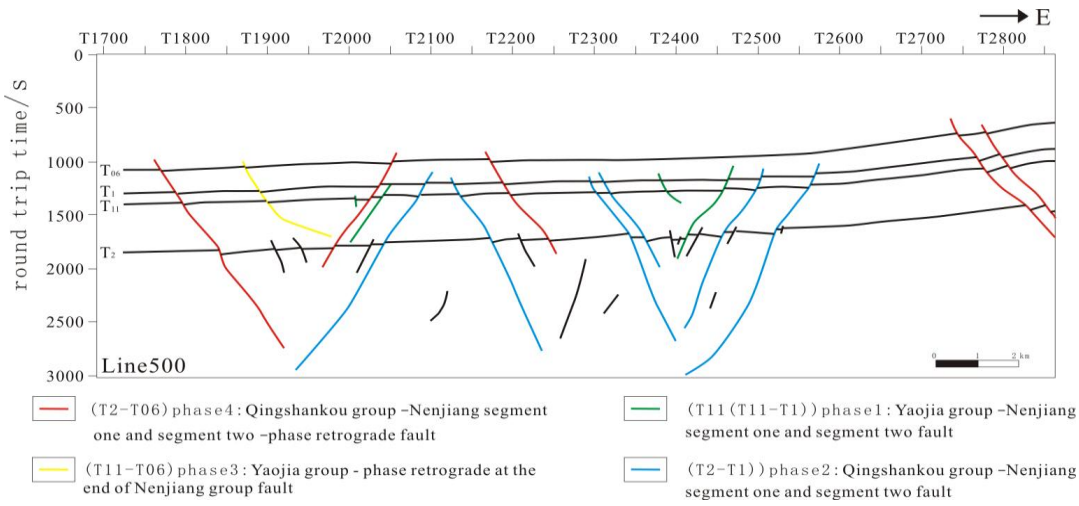

Fig.6. Characteristics of fault trans-formational and activity phase in T11 interface

Fig.6. Development characteristics of polygonal fault and tectonic fault in the typical seismic section in Maoxing syncline.

From fault activity frequency in growth index section, the Qingshankou group, Yaojia group, Nenjiang group segment one and segment two and Nenjiang group segment three and segment four are intense deformation periods.

III. TECTONIC EVOLUTION STAGES OF GULONGNAN REGION

Research of tectonic evolution has important effect on understanding depositional filling process,controlling oil and gas generation,migration and accumulation.This study mainly select typical seismic section to recover balanced section.

3.1 Principle to recover balanced section

(1) Concept of balanced section.

Balanced section is a reasonable section which can be recovered to the original undeformed state by a certain principle[2].

(2) Production process of balanced section.

To produce balanced section, should avoid to comply with the area conservation rigidly, tectonic characteristics of the specific region must be given full consideration.To recover balanced section , there are mainly several following steps[3]:

(Ⅰ)Section selection: select the section which has the same direction with main tectonic direction(principal stress direction) .Based on the area conservation and

"geology" conservation, to recover balanced section.

(Ⅱ)Remove fold: analyze the fold formation mechanism,apply the theory that the fault is related with fold to remove fold.

(Ⅲ)Denudation amount recovery:mainly use the layer extrapolation to recover denudation amount.

(Ⅳ)Layer flattening:suppose the sedimentary layer is horizontal before a certain period of tectonic movement.

(Ⅴ)Compaction correction: use the correction curve to correct compaction amount.

3.2 Evolution stages in Gulongnan region

Through the recovery of typical balanced section(figure7),combine with the study of regional tectonic evolution, the study area mainly has the following several stages since Qingshankou formation sedimentary period:

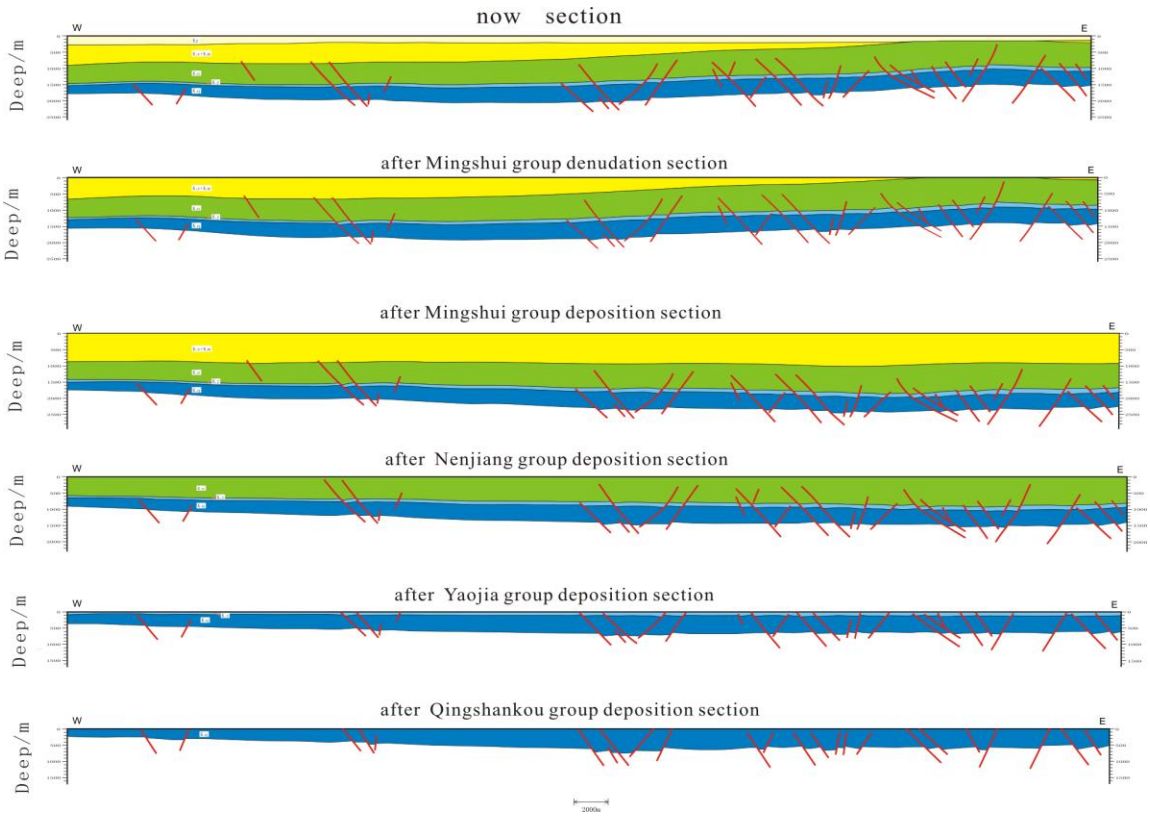

Fig. 7. Balanced section recovery in Yingtai and Aobaota three-dimensional area

(Ⅰ) Extend and downwarp stage: this stage mainly occurs at the Qingshankou group to the Nenjiang group.Based on the balanced section recovery, the sedimentary layer thickness is large and develop a lot of faults with small displacement, horizontal stretching quantity is small,mainly show the stable tectonic thermal subsidence.

(Ⅱ) Weak compression and denudation stage: this stage mainly occurs at the end of the Nenjiang group to the beginning of the Sifangtai group.Be affected by the subduction from Izanagi plate to Eurasia plate, the eastern Songliao basin has been strong uplifted, suffered different degree of denudation.Be affected by the early tectonic framework which show"high in the West and lower in the East",the terrain in study area near Daqing placanticline is relatively lower and still suffered from mild denudation.

(Ⅲ) Steady subsidence stage after weak compression: this stage mainly occurs at the Sifangtai group to Yian group. Regional structure is relatively stable, fault activity is weak.

(Ⅳ) Compression and inversion stage: this stage mainly occurs at the end of Yian group.Affected by the subduction of the Pacific plate, the Songliao basin is intensively compressed,formation is fold modified,Daqing placanticline formed,the Gulong syncline,Maoxing syncline and Yingtai nose-like structure in the study area formed at the same time.The Sifangtai group and Yian group located in the tectonic high position, suffered from intensive denudation.The Nenjiang group also suffered different degree of denudation.Formed the tectonic framewoork which show cncave and convex alternately.

(Ⅴ)Reform stage:since the neogene sedimentary period,the tectonic deformation in the study area is weak, faults are not active.

IV. CONCLUSION

(1) In the northern area, the faults are tectonic genesis,the southern area develop polygonal faults which connect the reservoir and hydrocarbon mother rock and provide sufficient channel for vertical migration.

(2) this study based on the observation of the trans-formational characteristics from seismic section,trans-formational characteristics mainly have the following categories: Yaojia group –Nenjiang segment one and segment two faults (type T11 - T1 or T11); Qingshankou group –Nenjiang segment one and segment two faults (type T2 - T1) ; less number of Yaojia group - phase retrograde at the end of Nenjiang group faults (type T11 - T06);Qingshankou group –Nenjiang segment one and segment two –phase retrograde faults (type T2 - T06).

(3)Based on the balanced section technique, analyzed the tectonic evolution stages of the study area. Research of tectonic evolution has important effect on understanding depositional filling process,controlling oil and gas generation,migration and accumulation.

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