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Synsedimentary compaction structure and its oil-gas significance

Yuchen Yang[1,2]

[1]School of Earth Science and Engineering, Xi'an Shiyou University, Xi'an, China
[2]Key Laboratory of Hydrocarbon Accumulation of Shaanxi Province, Xi'an Shiyou University, Xi'an, China

Abstract: *Syndepositional structure is mainly formed under the action of fault activity and sedimentary filling and compaction, and developed in the extensional normal fault descending wall in the tension field environment. In this paper, the concept, formation and development of syngenic structures are described, and the influence and significance of synsedimentary compaction structures on oil and gas are explored.*

Keywords: *Synsedimentation overburden structure; Oil and gas; Influence and significance*

1. Introduction

Generally, the structures formed in the sedimentary process are called synsedimentary structures, in which differential compaction plays an important role. Synsedimentary structures are generally developed in sedimentary basins. They are closely related to the generation, migration and accumulation of oil and gas because they develop at the same time and have an impact on the development of sedimentary and tectonic. It is of great practical significance to study the formation and development of the synsedimentary compaction structure and understand the significance of the structure to hydrocarbon migration and accumulation and exploration.

2. Basic overview of syndepositional structure

Syndepositional structure mainly refers to the structure formed during deposition. In terms of its morphology, it is generally intrabinal fault and fold deformation, which develops at the boundary of discrete plate or the upper wall of syndepositional fault in intrabinal slightly deformed faulted basin. According to the stress of syndepositional anticlines, syndepositional anticlines can be divided into compression syndepositional anticlines, tension syndepositional anticlines, reverse traction anticlines and so on. The geometric description of syndepositional structures is an important basis for the study. The description is initially presented in the plane and section. On the plane, it is mainly studied from the aspects of fault strike, curvature, angle between fault and branch fault, etc. The shape is presented in the aspects of feather, parallel, horsetail, etc. In section, syndepositional structure is more intuitive shape is "multi" shape.[1]

3. The formation and development of synsedimentation overburden structure

3.1. Formation

Synsedimentary compaction structure is formed in the process of deposition. In the synsedimentary faults under long-term activities, abrupt fault break zone or fault slope zone is formed, thus forming the boundary of paleotectonic unit and sedimentary facies domain, and controlling the overall distribution of sedimentary facies zone. There is a certain relationship between the distribution of synsedimentary faults and sedimentary sand bodies, which is mainly manifested in the control of the development and distribution of sedimentary system. The syndepositional fault is also related to the judgment and cause analysis of the pelvic floor property. From the exploration practice in our country, we can also see that most of the eastern oil-bearing areas are related to the syndepositional structure. With different lithology conditions, the syndepositional structures are also different. When the strata plasticity is too large, it is easy to form folding structures such as reverse traction. When the brittleness of rocks is too

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large, it is easier to form secondary faults in the same direction or reverse direction. Mudstone has the highest plasticity and the corresponding brittleness is relatively low, while conglomerate has the highest brittleness and the corresponding plasticity is the lowest. Rolling anticline is not easy to appear at the edge of the pelvic floor or around the controlled fault, mainly because the grain size of the sediments here is relatively large, and the rock brittleness is very large. It is easy to form rolling anticlines in the depression slope zone, mainly because the grain size of the sediments above the slope zone is relatively fine, generally sand and mudstone interbedded deposition. As is shown in Table 1, there are different types of sedimentary structures, mainly including abiogenic and biogenic structural forms.

Table 1: Types of sedimentary structures

Abiogenic structure		**Biogenic structure**
mechanical formation (primary structure)	chemical formation (secondary structure)	
stratified structure	dissolved structure	biological structure
plane structure	condenses structural	biological stratification
deformable structural	dissolving-condensing structural	biovestiges

3.2. Development

Under the background of regional tension, syndepositional structures are formed. When the extensional faults extend horizontally and the structures settle, contact zones are formed on the ground of the hanging wall and the contact surface of the faults, with different characteristics. In the parts with small curvature of the section, closed contact zones are formed, and positive traction structures are easily caused on them. For the part with large curvature of the section, the void contact zone will be formed, which is easy to cause the reverse traction deflection of the descending wall of the growth fault. When there is great brittleness in the descending wall strata, the same direction of secondary faults and reverse secondary faults will be formed above the closed zone and void zone. During the continuous development of growth faults, more sediments were deposited in the descending wall under the action of sedimentation. In the space caused by the reverse traction deflection, when the sediments filled the space, the sediment weight would produce two pressures on the section and the flexural surface, thus making the reverse traction deflection gradually develop into the synsedimentary anticline. Under the joint action of fault and deposition, local tectonic stress is formed and secondary fault is produced. When the tectonic subsidence occurs, the strata in the hanging wall of the growth fault gradually slide downward along the curved fault plane, and the strata also slowly incline toward the fault plane. When the strata are away from the fault plane and turn upward, the degree of incline gradually weakens and eventually becomes non-incline. At the high curvature point of the fault plane, when the hanging wall stratum is crossed, the stress state of the rock strata at the contact position of the two strata changes dramatically, and is subjected to very strong local tectonic stress, especially at the terminal or turning point of some small cracks. The phenomenon of stress concentration is relatively common. Once the stress is greater than the strength of the rock, the cracks will slowly increase, thus developing into secondary faults.[2]

4. The influence and significance of synsedimentary compaction structure on oil and gas

4.1. Influence of structure on hydrocarbon migration and accumulation

In general, it is believed that the growth fault plays a certain sealing role during the activity hiatus, and plays a role of channel migration during the activity period. Small fractures develop into secondary syndepositional faults under the action of stress concentration and thus low potential areas are formed within a specific range, that is, oil and gas migration direction areas. During fault activity, oil and gas migration channels are usually used in the vertical direction. However, when the hanging wall of the fault slowly settled, the deposited sand body began to push forward, resulting in excessive sedimentary load above the fault plane. For the gravity of the sediment, it can be divided into two kinds of forces, namely, the sliding force along the section and the vertical pressure on the section. Such lateral pressure mainly acts on the fault plane, which can inhibit the migration of oil and gas in the fault plane, thus enhancing its sealing property. At the same time, the fault rock and mudstone contaminated zone developed in the fault zone can make it have strong sealing property when the fault is in static state. Due to the far distance between the reverse secondary fault and the syndepositional fault section, the

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lateral compression caused by sediment gravity is relatively weak, but it is also a stress release area. Compared with the second-order reverse fault of the same direction, it is easier to become the channel of oil and gas migration and accumulation. It also plays a role in regulating the distribution of oil and gas. During oil and gas migration and accumulation, what factors will affect the dredging and plugging of the fault zone? As shown in Figure 1, they are the influencing factors of fault transport and plugging, mainly including ten factors.

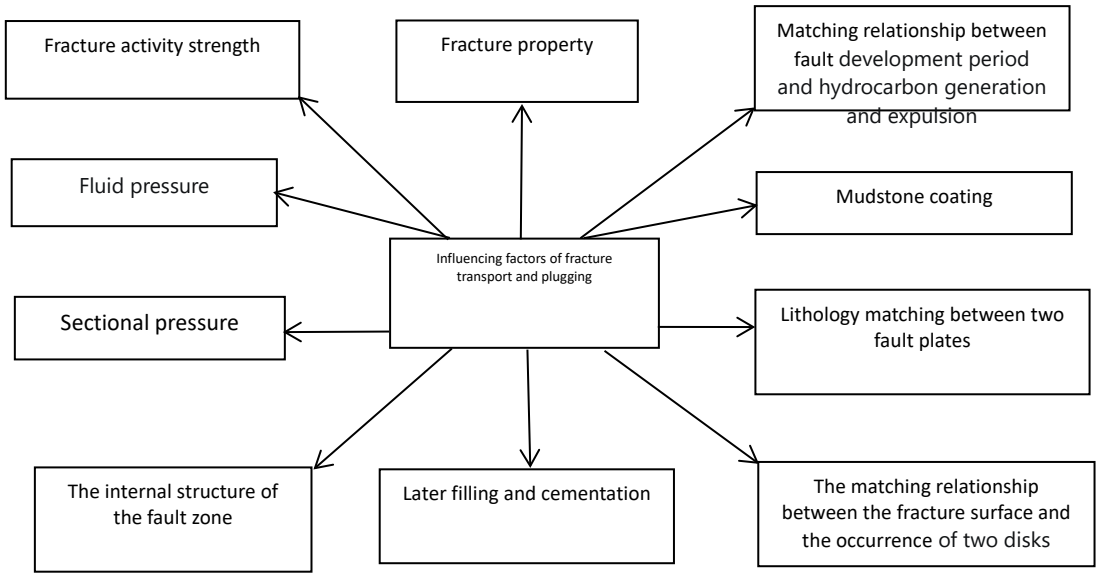

Figure 1: Influencing factors of fracture transport and plugging

4.2. Significance of structural analysis to exploration

Synsedimentary compaction structure generally develops in different sedimentary basins, and synsedimentary structure can be developed in any basin and synsedimentary structure has a certain relationship with oil and gas generation. People gradually have a deeper understanding of the formation of syndepositional structures, and gradually realize that they are closely related to the formation of oil and gas traps and the development of oil-generating depressions. Syndepositional anticline plays an obvious role in oil and gas accumulation, mainly because it has the original dip when it was deposited, and the overlying strata near the depression thickened to produce a certain pressure difference, which provided a good condition for the early migration of oil and gas. In the syndepositional anticlinal paleouplift zone, there are trap structures, which are mostly favorable facies belts with good porosity and coarse grain size, and also places of high oil and gas accumulation and production. For the larger syngenetic structures, they directly control the formation and development of oil-bearing basins. Therefore, the main active period of large-scale syngenetic faults is also the important development period of oil-generating depressions, which has a certain control effect on the distribution of oil-generating depressions. In the upper wall of synsedimentary normal fault, the reverse traction structure is developed, which belongs to the structure of high oil and gas production. It can be seen from a large number of oil and gas exploration practices that the syndepositional anticlinal belt developed in Mesozoic and Cenozoic sedimentary basins is very favorable to oil and gas accumulation and is also an important exploration target.

Taking syndepositional structure of a depression as an example, syndepositional structure is also very favorable for hydrocarbon accumulation due to its unique sedimentary conditions, tectonic conditions and tectonic position, which is of great significance for petroleum exploration. At the early stage of syndepositional fault activity, many types of sand bodies of different types developed in the lower sequence domain due to relatively shallow water and very active hydrodynamic conditions. When fault activity continued to develop, the depth of water increased, and fine sediment would be covered on the sand bodies. The mudstone rich in organic matter is the high quality oil source rock for the overlying high level sedimentary sand body. Syndepositional fault activities play a certain role in controlling the distribution of sand bodies. In the lower sequence domain, sand body types include undercut channel filling and lower fan. Syndepositional fault activity has a great influence on the changes of the reservoir physical properties of the far and near shore fan of the lake. For syndepositional faults with long-term activity and a large range, due to the large kinematic force of the

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fault, the burial is very deep, and the grain size of the sand-gravel rock mass is relatively coarse, and the lithology compact is relatively poor, the reservoir physical properties are relatively good at the front of the fan body. Because of the different spatial configurations of syndepositional faults and controlled sand bodies, different transport system types are formed. During episodic activity of the syndepositional faults in this depression, the section is a very favorable channel for oil and gas migration. Therefore, the most important oil and gas migration zone in the faulted basin is the negative flowerlike structural zone formed by the tensile fault zone. During the syndepositional fault activity, the sedimentation velocity of a certain segment of syndepositional tectonic belt in this depression was relatively fast, showing prominent differential compaction and developing abnormal high pressure pockets, which ensured sufficient migration force of oil and gas. In terms of oil and gas migration, episodic activities of syndepositional faults and developed sand bodies provide good pressure relief channels. Therefore, the formation of syndepositional structures in this depression is very important for the generation, migration and accumulation of oil and gas.

5. Conclusions

Synsedimentary overburden structure is mainly affected by tectonic activity and sedimentation and the development of secondary faults in synsedimentary structure is controlled by rock properties. Syndepositional structures are widely developed in faulted basins, which are closely related to the distribution of reservoir facies belts and the development of oil-generating depressions. They are usually shown as intrabinal and marginal faults and fold deformation. In the hanging wall of syndepositional faults, different sedimentary folds provide better trapping conditions for oil and gas accumulation, and secondary faults also transversely cut the syndepositional folds formed in the early stage, thus forming a variety of fault traps.

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