IOSR Journal of Engineering (IOSRJEN) **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719
Vol. 05, Issue 07 (July. 2015), ||V3|| PP 10-13

Characteristic of Cracks in Tight Sandstone Reservoir

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Abstract: - Cracks not only can be used as a good reservoir space, but also is the important reservoir seepage channel. Study area mainly has tectonic cracks, bedding cracks and diagenesis cracks. Tectonic crack is usually characterized by irregular serrated, wear layer and oblique development. Bedding cracks grow between two layers which have different lithology. Diagenesis cracks are controlled by diagenetic process, and it is usually micro cracks. Tectonic stress controlled the cracks plane and vertical distribution. Sedimentation determines the original composition and structure of the reservoir rock. Different sedimentary microfacies have different cracks development degree. Pressure cracks formed by the real pressure. Dissolution cracks formed by the dissolution.

Keywords: - *Cracks; Tight sandstone reservoir; Controlling factors; Characteristic*

I. INTRODUCTION

Cracks not only can be used as a good reservoir space, but also is the important reservoir seepage channel. With the change of the structure of the world oil and gas resources, and the further research of unconventional oil and gas, micro cracks in the reservoir achieve more attention of many scholars. Through the cores, thin sections, X-ray diffraction analysis, ZangShibin analyzed micro cracks reservoir in the south oilfield of Chaidamu basin, and put forward the concept of effective pore throat radius to describe reservoir pore structure characteristics [1]. HaoMingqiang believes micro cracks low permeability reservoir is mainly provided by the micro crack seepage ability [2]. NanJunxiang point out the micro crack on the matrix cracks connected is of great significance, which is one of the productive factors of crude oil [3]. Therefore, the micro cracks reservoir development characteristics and main control factors research is of great significance for dense reservoir exploration and development.

II. THE GENERAL SITUATION IN THE STUDY AREA

Daan oilfield is located in the southern songliao basin in the central depression in the secondary structural belt. Study area located between the central depression area and west slope area. It is the transition zone of two relative elevation and subsidence movement. It belongs to the terrace extrusion structure oil and gas accumulation zone. According to the composition, particle size, the division of property, different standards have different results.

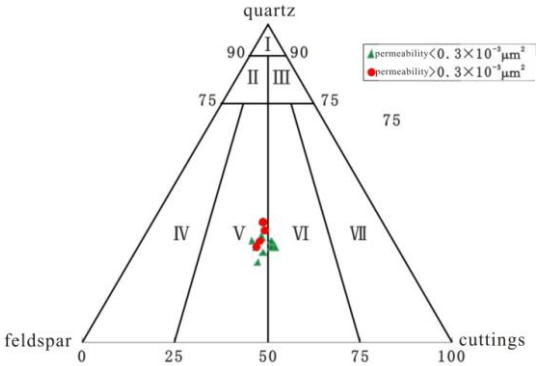

Fig.1 Rock composition in the study area

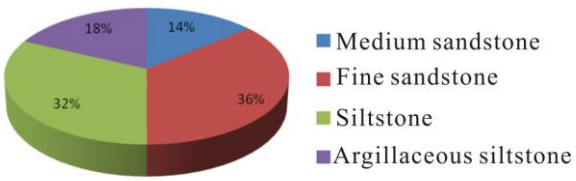

Fig.2 Lithology distribution in the study area

From the composition, the study area reservoir rocks are feldspar lithic sandstone and lithic feldspar sandstone (Fig.1). From the granularity, purpose layer in the study area mainly fine sandstone and siltstone, with part of argillaceous siltstone and sandstone (Fig.2).From the physical properties, mainly belong to low - low - density, ultra-low reservoir (Tab.1).

Tab.1 Property classification standard in the study area

Permeability $K/10^{-3}\mu m^2$			Porosity φ/%		
Level	Scope	Proportion %	Level	Scope	Proportion %
High permeability	500≤K＜2000	0	High porosity	25≤φ＜30	0
Medium permeability	50≤K＜500	0	Medium porosity	15≤φ＜25	0
Low permeability	10≤K＜50	0.7	Low porosity	10≤φ＜15	4.9
Extra low permeability	1≤K＜10	2.8	Extra low porosity	5≤φ＜10	57.3
Ultra-low permeability	0.1≤K＜1	55.9	Ultra-low porosity	0≤φ＜5	37.8
Tight	0.01≤K＜0.1	40.6			

III. DEVELOPMENT CHARACTERISTICS

Study area mainly has tectonic cracks, bedding cracks and diagenesis cracks. Tectonic crack is usually characterized by irregular serrated, wear layer and oblique development. Bedding cracks grow between two layers which have different lithology. Diagenesis cracks are controlled by diagenetic process, and it is usually micro cracks. Different causes of micro cracks with different morphological characteristics. Study area widely exist micro cracks reservoir (Tab.2).

Tab.2 Micro cracks geological genetic classification

	Type		Morphological characteristics	Genesis
Micro cracks geological genetic classification	Tectonic crack		Irregular serrated, wear layer and oblique development	Associated with fold fault development
				Associated with fault
	Bedding cracks		Grow between two layers	In the early development of laminated compaction and the late tectonic uplift
	Diagenesis cracks	Intragranular cracks	Development in the granules, no cut grain edge	Strong mechanical extrusion and later dissolution
		Edge cracks	Up along one edge of the particle distribution	
		Wear particle cracks	Through the mineral grains	

2.1 Tectonic crack

Tectonic cracks is formed after the elastic strength in the process of tectonic deformation [4-6]. Based on 8 Wells core observation, I found that the cracks development zone macro local structure is few, only two high angle macroscopic structural cracks, one low angle of macroscopic structural cracks. Among them, the high angle macro structural cracks extended length of 2-15.7 cm, open degree is 0.6 ~ 0.8 mm, siliceous filling. Low langle macro structural cracks has the crack open degree 0.6 cm, calcite filling (Fig.3). Tectonic crack is usually characterized by irregular serrated, wear layer and oblique development. With the cracks structure formed on the mechanical stress, it is generally not develop according to the grain layer or horizontal direction, it usually develop according to the tectonic stress direction outspread, or accompanied by fault, fold development.

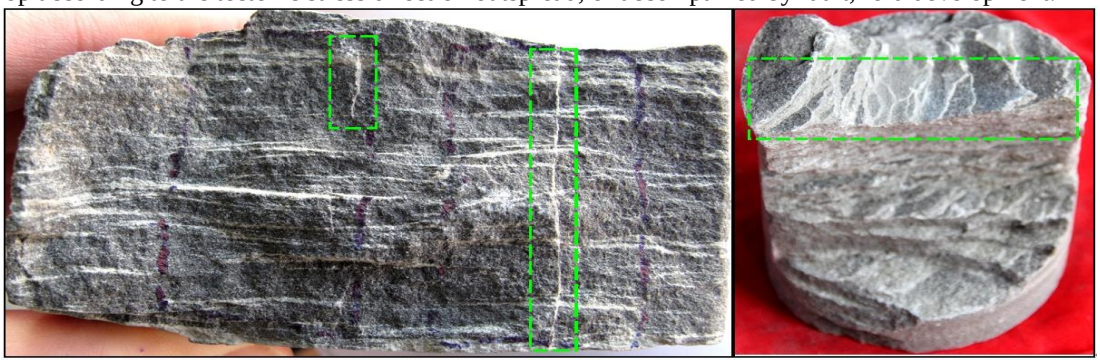

Fig.3 Morphological characteristics of tectonic cracks

2.2 Bedding cracks

Bedding cracks refers to split crack along the sediments. In the bedding cracks development area, bedding cracks bifurcate, merger and extend. It appears smaller capillary and intragranular cracks around the bedding cracks. Through 8 Wells core chip microscopically observed, we found core bedding extremely developed, the extension length 1 ~ 10 cm or more, the open degree is 4.8 um (Fig.4). The bedding crack is in the development of sedimentary laminae. It mainly developed in distributary channel and distributary bay.

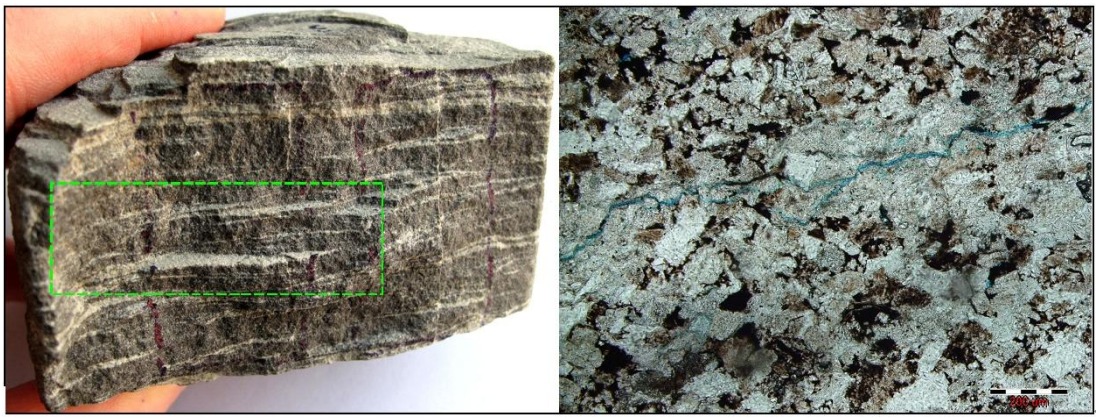

Fig.4 Morphological characteristics of bedding cracks

2.3 Diagenesis cracks

Diagenesis cracks refer to the crack formed from the formation to the consolidation diagenetic stage, due to the overlying water shrinkage and stress over itself [7-8]. Fuyu reservoir micro cracks in Daan oilfield developed well, the main types is intragranular cracks, edge cracks and wear particle crack. Intragranular crack distribute in quartz and feldspar cleavage crack, it never cut mineral edge. Edge cracks exist between mineral grains, it distribute along the edge of mineral grains. The formation has strong relationship with mechanical compaction, pressure solution and the late tectonic compression. Through the core chip microscopically observed, development degree is high. We found intragranular cracks and edge cracks in 2133.7 m in the study area. Intragranular crack opening degree is 3.5 um, edge crack opening degree is 7.8 ~ 4.2 um. microns. We found wear particle crack in 2106 m in the study area. The opening degree is 5.3 ~ 10 um (Fig.5).

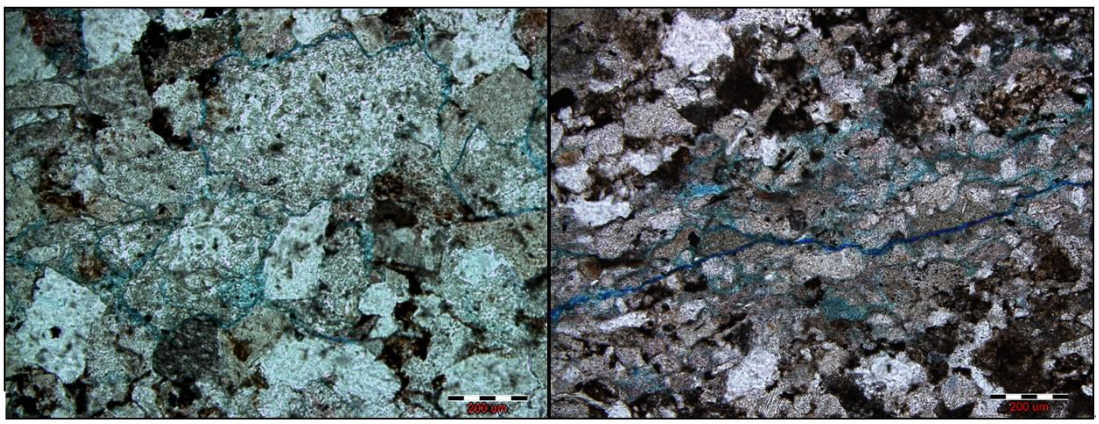

Fig.5 Morphological characteristics of diagenesis cracks

IV. CONTROLLING FACTORS

Daan oilfield reservoir mainly experienced four period of geological tectonic evolution, which has experienced one lifting effect and the extrusion of three different directions. The strata uplift for buried sandstone formation is a pressure unloading process, within the elastic range of the rock, it can also cause the springback of sandstone formation, resulting in sandstone formation pore expansion. Horizontal tectonic extrusion can make the rock deformation. When the stress exceeds the elastic limit of the rock, plastic deformation occurs. When the stress exceeds the ultimate strength of the rock, fracture deformation occurs.

Through the study of core data and slices in the sedimentary characteristics of tight sandstone reservoir fracture, we believe that the sedimentary environment decided the premise condition of reservoir physical properties. Different lithology and physical properties of sedimentary microfacies cause different mechanical properties of

sedimentary microfacies, leading to the different degree of cracks development. Sedimentation is not only the original control effects of pore structure, but also the control function of diagenesis. It is the determinant factor of fracture reservoir properties. Sedimentation determines the original composition and structure of the reservoir. It also determines the mineral content and pore structure of the original, and the influence on the late diagenesis.

All kinds of micro cracks formation promote the later dissolution of secondary porosity. At the same time, all kinds of cracks itself is also a good reservoir space, density reservoir physical properties were improved. Though the development of Daan oilfield reservoir micro cracks within their own scale is small, but in the later transformation under the action of underground fluid, intragranular cracks, edge cracks can occur further dissolution. It cause cracks and local corrosion secondary pore space, it can be good reservoir space in the tight sandstone reservoir. Wear particle cracks are more likely to be fluid corrosion, especially in the intersection, turn end and end of the crack, secondary pore space can be formed easily. It improved the tight sandstone reservoir physical property.

V. CONCLUSION

1. Study area mainly has tectonic cracks, bedding cracks and diagenesis cracks. Tectonic crack is usually characterized by irregular serrated, wear layer and oblique development. Bedding cracks grow between two layers which have different lithology. Diagenesis cracks are controlled by diagenetic process, and it is usually micro cracks.
2. Tectonic stress controlled the cracks plane and vertical distribution. Sedimentation determines the original composition and structure of the reservoir rock. Different sedimentary microfacies have different cracks development degree. Pressure cracks formed by the real pressure. Dissolution cracks formed by the dissolution.

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