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The Relationship Between the Fluid Classification of Glutenite Reservoir Hydrogenetic and Hydrocarbon Accumulation

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With the help of core and logging data, laboratory test data, by using classified evaluation of glutenite based on classification of sedimentation, subdividing the glutenite facies into tractive-current glutenite and gravity-current glutenite. The tractive-current glutenite is mainly a set of fan channel deposits and underwater distributary channel deposits. Gravity-current glutenite is a set of debris flow deposition and debris flow deposition. Predictive results are found to be high accuracy by first time using glutenite logging identification technology, pseudo-sonic wave impedance technique. The result of research shows that the difference of sedimentation and conglomerate is the main factor controlling the reservoir physical properties and productivity in Mabei area. The physical and oily and oil test production are mainly controlled by the sedimentary genesis of the glutenite reservoir and less by diagenesis modification. The results show that the development of tractive-current glutenite in underwater diversion channel and fan-shaped river channel micro-phase get high oil saturation and Good oil test result. The physical and oil-bearing properties of traction glutenite are better than those of gravity glutenite, rich oil layers are mainly the traction glutenite, and poor and none oil layers are mainly gravity glutenite. Therefore, the distribution of glutenite due to the fan-delta underwater distributary channel tractive-current should be a favourable zone for future well location deployment.

1. Introduction

Based on years of the scholars' research about the glutenite sedimentation and reservoirs, involving logging identification of gritstone, lithology (phase) division, sedimentary facies study, reservoir physical property analysis, diagenesis, analysis of main factors of physical property, earthquake prediction and so on. The few related studies are listed below. Hubbard et al. (2007) examined the Cerro Toro Formation glutenite in Santiago Region of Chile and concluded that the glutenite is an underwater fan-shaped deposit system consisting of three different facies. Ernando and Fathoni (2013) argued that the properties of glutenite reservoir depend on the heterogeneous content and pore structure. Some scholars recognized the great physical relationship between heterogeneous content (especially the muddy miscellaneous content) and the sandstone conglomerate reservoir but didn't find that the root cause of the difference in hetero-content is the difference in the nature of the deposited fluid. The study of sand and gravel reservoirs in China is earlier, involving logging identification of gritstone, lithology (phase) division, sedimentary facies study, reservoir physical property analysis, diagenesis, analysis of main factors of physical property, earthquake prediction and so on. Li et al. (2012) conducted the research on factors of glutenite reservoir property controlling development of Bonan depression in Shahejie group of nearshore subaqueous fan, fan middle phase is considered the root fan and fan subfacies is better, but not aware of the internal factors is actually completely belongs to gravity-flow fan root causes and has some traction for the sake of fan flow causes. Jin (2013) carries out lithologic logging identification of glutenite sandstone of Shahe formation in Xujiaweizi fault depression, and divided lithology into 3 categories, sandstone, glutenite and mudstone, which is too rough. According to the difference of physical property and rock structure between different conglomerate phases, Jiang et al. (2013) further subdivided the conglomerate facies into granular support conglomerate,

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heterogeneous support conglomerate and mixed support conglomerate facies. Although some of the major oil and gas basins in China have carried out extensive research on the characteristics of sandstone and conglomerate reservoirs, Therefore, study on coupling relationship between sandstone and oil-gas distribution based on sedimentary origin classification also has great theoretical reference and comparative significance for the reservoir characteristics and favourable area prediction of sandstone at home and abroad.

2. Geological setting of the study area

The Mahu Depression is a secondary tectonic unit in the central depression of the Junggar Basin, connecting with the Krai Uxia fault zone in the west. The north slope of the north is located in the north of the Mahu depression (Figure 1). The tectonic pattern of Mabei and Maxi is formed in the early Cretaceous. The overall performance shows a southeast tilt of the flat monoclinic form, and partly shows low amplitude anticline and nasal structure (Figure 1).

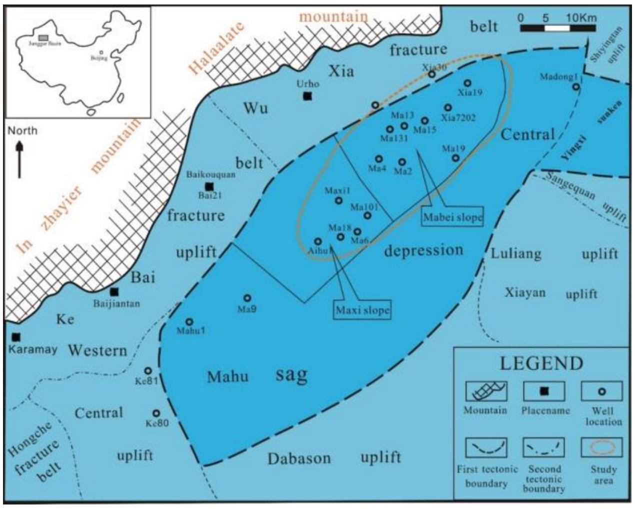

Figure 1: Geographical location and structural zoning map of the study area

3. Sampling and analytical methods

3.1 Source of Glutenite Genetic classification theory

Actually, among the traditional sedimentary classification methods, for instance sandstone classification, delta classification, marine carbonate sedimentary facies belt classification etc., genetic classification is widely accepted now. This theory can be introduced into the classification of glutenite.

Sand conglomerate is mainly formed in alluvial fan, fan delta, near shore underwater fan and other sedimentary environment. The sedimentary fluid properties of each sedimentary environment can be divided into two categories: tractive-current and gravity-current. Take fan delta deposition as an example. Back in the 1980s and 1990s, Scholars at home and abroad have realized that fan delta has the characteristics of tractive-current and gravity-current interaction deposition. The gravity-current deposition formed during the period of the catastrophe corresponds to the microfacies of mud flow in the subfacies of fan delta plain and debris flow in the subfacies of fan delta front. The tractive-current deposition formed during the period of the catastrophe is mainly corresponding to the microfacies of stream channel in the subfacies of fan delta plain and underwater distributary channel and river mouth sand bars in the subfacies of fan delta front. However, according to massive researches of literature on fan delta sedimentation and reservoir, most domestic scholars fail to recognize or identify the flow microfacies of debris flow and debris caused by gravity-flow. This is one of the reasons leading to the classification of sand conglomerate lacking sedimentary genetic classification.

3.2 Standard of Glutenite Genetic classification

Glutenite in the glutenite reservoir of fan delta facies contains two different sedimentary genesis. The factors that affect the reservoir properties of glutenite reservoirs and even the whole clastic reservoirs are divided into sedimentary factors and diagenetic reformation factors. Generally speaking, sedimentation is the main factor, while diagenetic transformation factor is an important factor. Through the previous research results can be seen, the diagenetic influence for the Mabei slope area of Baikouquan glutenite reservoir physical properties are not decisive, because its dissolution is not very strong, so it cannot form pores enough. That is to say, the dissolution pore has not become an integral dominant pore type. On the contrary, the remaining intergranular pore is the important pore type for the glutenite reservoir in the study area. In other words, the controlling factors of control and the north slope of Baikouquan glutenite reservoir is sedimentary sandstone and conglomerate.

Macroscopically, the tractive-flow sand conglomerate develops in the fan river microfacies of the fan delta plain subfacies, the bottom underwater distributary channel microfacies of fan delta front subfacies (The top of the river is gravel and sandstone, which is generally difficult to preserve), which forms the main body of channel deposition. The size of gravels is in range of 2mm-15mm, particle sorting is good, medium-preferably grinding degree, particle support, positive grain order, parallel bedding, lateral accretion cross bedding etc (Figure 2).

The gravity-flow sand conglomerate develops in the microfacies of the subfacies in the fan delta plain, the detrital flow microfacies of the subfacies in the front edge of the fan delta, which forms all of its sedimentary bodies. The size of gravels is normally larger than 20mm, particle sorting is bad, size confounding, maximum particle size up to 10cm, medium-poor grinding degree, the argillaceous content is obviously high, particles are mostly floating structure and underflowing structure, no tractive-current sedimentary structure (Figure 2).

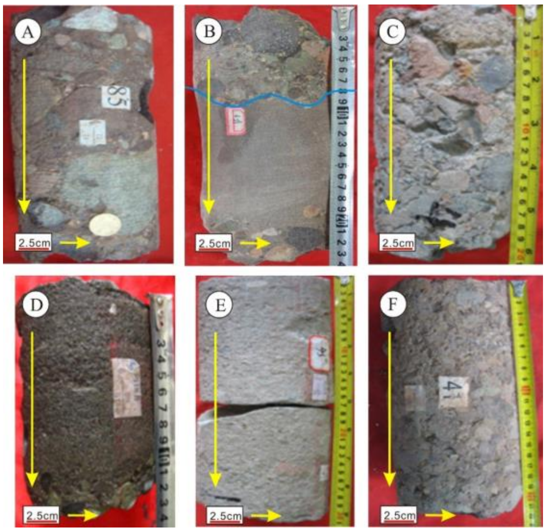

Figure 2: Core photos of different genetic sandstone conglomerate

4. Results

4.1 Differences of reservoir space type

Glutenite reservoir space types of the Mabei slope of Triassic Baikouquan formation include intergranular pore (including residual intergranular pore), intragranular dissolved pores and interface joints etc. The reservoir is dominated by secondary porosity, but the reservoir space between the different sedimentary types of glutenite is very different.

The types of reservoir space of tractive-flow glutenite are mainly intergranular pore (56.6%). The proportion of intragranular dissolved pores and interface joints is smaller. The gravity-flow glutenite is mainly dissolved pores (55.5%). Only 10.5% of the intergranular pores were found.

Gravity-flow sand conglomerate has a relatively high content of mud and heterogeneity, generally between 6.0 and 9.0%. This makes the pores in the primary grains almost completely filled up. The storage space type is dominated by secondary pores, such as intergranular dissolution pores (Figure 3). Tractive-flow sand conglomerate has a relatively low content of mud and heterogeneity, generally lower than 2.0%. This can retain primary pores, such as intergranular pores (Figure 3), making storage space significantly improved. This difference can be completely fitted with the fluid mechanism of formation period. The gravity-flow has no mechanical differentiation during the sand conglomerate deposition, leading to chaotic melange. However, the tractive-flow gets mechanical differentiation during the sand conglomerate deposition, leading to lower shale content, making it possible to keep favourable storage space.

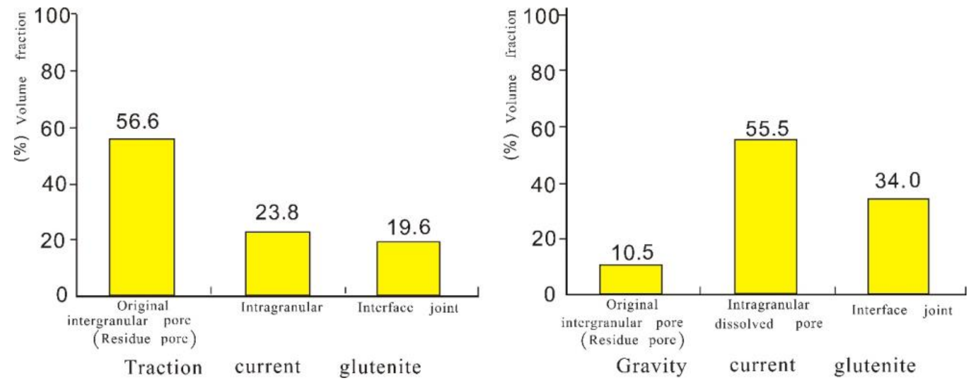

Figure 3: The differences of reservoir space type between different sedimentary origins of glutenite of Baikouquan Formation in the Mabei Slope

4.2 Differences in physical properties of glutenite of different sedimentary origin

The Mabei slope of Triassic Baikouquan formation of glutenite reservoir generally shows low porosity, low permeability and strong heterogeneity, but the differences in physical properties of glutenite of different sedimentary origin is great. The average value of porosity and permeability of tractive-flow glutenite is 9.85% and 5.23x10^{-3}um^{2} respectively, and most of the porosity value falls in the 8%-12% range, and the permeability value is mostly larger than 3x10^{-3}um^{2} (Figure 4). The average value of porosity and permeability of gravity-flow glutenite is 5.70% and 2.48x10^{-3}um^{2} respectively, and most of the porosity value falls in the 5%-8% range, and the permeability value falls in the 1x10^{-3}um^{2}-3x10^{-3}um^{2} range. Two typical examples are listed below to prove that there is a great difference in reservoir characteristics between glutenite reservoirs with different sedimentary origin or sedimentary microfacies (Hart and Plint, 2003).

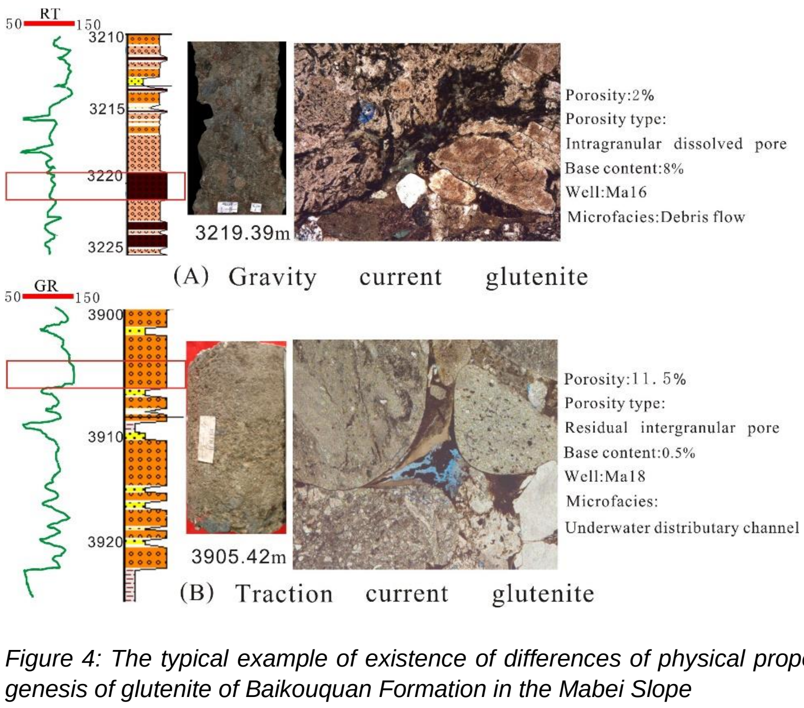

Figure 4: The typical example of existence of differences of physical property between different sedimentary genesis of glutenite of Baikouquan Formation in the Mabei Slope

The characteristics of tractive-flow sand conglomerate in the microfacies and underwater distributary channel of the fan are shown in the characteristics of good separation, high degree of roundness and low content of mud. The log is characterized by low GR and low RHOB. The microcosmic observation of the cast chip found that its matrix content was lower than 2.0% (Hickson and Lowe, 2002). The storage space type is dominated by the remaining intergranular pores, the secondary pores are less, and the final porosity is higher. However, the characteristics of gravity-flow sand conglomerate core characteristics of debris flow microfacies and debris flow microfacies show that the characteristics of low separation, low grinding degree, high mud and mixed base content and more floating gravel particles. The logging curve shows the characteristics of high GR, high RHOB. The microcosmic observation of the cast sheet found that the heterostructure was more than 6.0%. The storage space type is dominated by secondary pores, and the remaining intergranular pores are very small, and the final porosity is low and the reservoir is poor (Gao et al., 2011).

5. Discussions

5.1 The sedimentary origin of sand conglomerate is the control factor of oil and gas production

The Baikouquan group of glutenite reservoir in the study area experienced a weak diagenetic transformation, thus different glutenite sedimentary origin is the fundamental factor that causes the large physical difference between the sand conglomerates, which in turn lead to huge differences in further test conclusion.
The oil test in the 3455-3475m depth of well ma 18 gave the result of 33.5t per day, making it the highest single well oil test in marbei area. Through the project team's lithology explanation, it is found that the oil section is mainly a tractive-flow sand conglomerate. Through observation of the depositional characteristics of the core, it is found that lithology is mainly fine conglomerate in grey, celadon, particle size even, high psephicity, developing positive rhythm sedimentary structure, low content of mud mixed base. It is a microfacies of subaqueous distributary channel in front of fan delta. Under microscopically, it is observed that the grinding of gravel particles was very good, the content of the mud is low, the pore type is dominated by the mesoporous pores, and the porosity is as high as 11.9% (Figure 5). This indicates that the tractive-flow sand conglomerate has good oil content and good reservoir performance (Clarke, 1979).
The oil test in the 3542m~3475m depth of well ma 5 gave the result no oil, making it the lowest single well oil test in Mabei area. Through the project team's lithology explanation, it is found that the oil section is mainly a gravity-flow sand conglomerate. Through observation of the depositional characteristics of the core, it is found that lithology is mainly pebblestone in motley, brownish red, particle size uneven, moderately psephicity, developing symmict structure instead of any tractive-flow sedimentary structure, high content of mud mixed base, floating graval grain in matrix. The sedimentary microfacies is a microfacies of the subfacies of the front edge of the fan delta. Under microscopically, the content of the mud matrix is high, and the pore type is mainly of corrosion or microfracture (interface fracture), and the porosity is as low as 5.6% (Figure 5). The results show that the oil-bearing capacity is poor and the reservoir performance is not good.

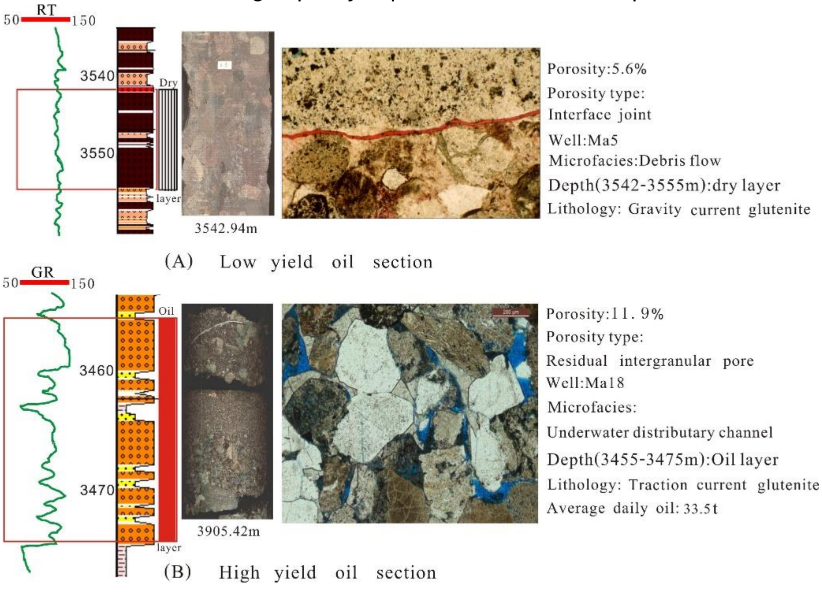

Figure 5: Comparative analysis of macro and micro characteristics of high oil production and low oil production

6. Conclusion

(1) There are great differences in macro and micro aspects of glutenite with different origins. These differences further lead to differences in physical properties of reservoirs. Among them, the tractive flow conglomerate is mainly composed of residual intergranular pores. The shale content is low, and mercury injection shows good separation of pore throat and larger pore throat radius. Thus, it has good physical properties, and good oil content. The gravity-flow sand conglomerate, on the other hand, is mainly secondary

dissolution pore. The impurity content of shale is high, and mercury injection shows poor separation of pore throat and small pore throat radius. Thus, it has poor physical properties, and poor oil content.

(2) Because the Baikouquan formation of glutenite reservoir is less affected by diagenesis effect, based on the analysis of the difference in the oil test results of the test section, it is considered that the sedimentary genesis of glutenite is the fundamental factor for controlling reservoir property, oil-bearing property and oil testing result. Therefore, a comprehensive evaluation of Baikouquan glutenite reservoir is carried out. The fan river, tractive-current glutenite developed in underwater distributary channel microfacies and pebbled sandstone reservoir are classified as class I favourable reservoirs. The debris flow and debris flow microfacies are classified into II type non favourable reservoirs. The overflow, tributary bay and prodelta mud microfacies in mudstone and silty mudstone are classified into non-reservoir.

(3) The fan river, tractive-current glutenite developed in underwater distributary channel microfacies and pebbled sandstone reservoir are the main reservoir in research area. tractive-current glutenite developed in each layer is the preferred target research area in the future production.

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