
Reservoir Characteristics of Xujiache Formation of Upper Triassic in Puguang Area

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Abstract

Stripper airflow (162~6504m³/d) has been found in Xujiache Formation of 11 exploration wells in Puguang area, which indicates that Xujiache Formation is of exploitation potential and could be an important layer system for long term stabilized development of Puguang gas field. According to the lithology analysis, it suggests that reservoir of Xujiache Formation is terrigenous clastic rock and of low compositional maturity and high textural maturity. And grain size of reservoir in Xujiache Formation is mainly fine grain and medium grain. Physical property analysis indicates that reservoir in Xujiache Formation is of poor physical property with porosity generally less than 4% and permeability less than $0.1 \times 10^{-3} \mu\text{m}^2$, being reservoirs are of low porosity and permeability or extra-low porosity and permeability. As a whole, physical property of T₃X², T₃X⁴ and T₃X⁶ is of good porosity and permeability and much better than that of T₃X₃ and T₃X⁵.

Keywords

Reservoir Characteristics, Xujiache Formation, Upper Triassic.

1. Introduction

Puguang area is located in the northwest of the upper Yangtze plate, to the west of which is EW-trend Micangshan thrust structural zone, to the northeast of which is NW-trend Dabashan arcuate thrust structural zone and to the northwest of which is NE-trend Longmenshan orogenic zone ^[1]. Puguang area went through passive margin sedimentation from Palaeozoic to Middle Triassic, after the marine carbonate sedimentation ended off by the Indosinian movement in the late Middle Triassic, foreland basin sedimentation happened in Puguang area, and there was extra-thick terrestrial redbed in Puguang area from the Late Triassic to the Early Cretaceous ^[2,3]. Reservoirs of the study area are of low porosity and permeability or extra-low porosity and permeability, but drilling wells indicate that Xujiache Formation of the upper Triassic in Puguang area is of good exploration potential.

2. Regional geologic setting

Puguang area is located in the northeast of Sichuan Basin, and can be divided into 5 primary structural units, Michangshan frontal thrust zone, Dabashan frontal decken structure, Chuanzhong structural subdued zone, Tongjiang-Changping structural zone and Xuanhan faulted fringing zone, with an area of 1116 km² ^[4](Fig.1). In 2003, important breakthrough was made in Feixianguan Formation of Well Puguang1. Now explored reserves of Feixianguan-Changxing Formation in Puguang gas field has been up to $4050 \times 10^8 \text{m}^3$, and stripper airflow (162~6504m³/d) has been tested in Xujiache Formation of 11 exploration wells, suggesting that shallow continental Xujiache Formation is of exploitation potential and could be an important layer system for long term stabilized development of Puguang gas field ^[5].

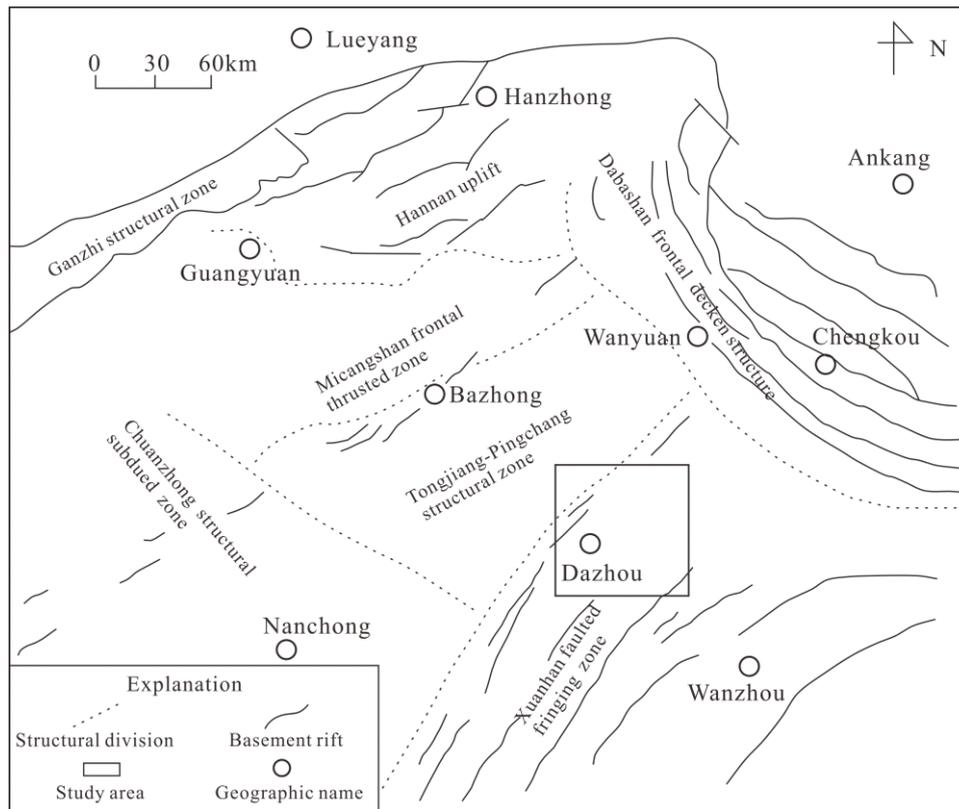


Fig1. The structural location of Puguang area

3. Petrological characteristic of reservoir in Xujiache Formation

3.1 Rock types

Reservoir of Xujiache Formation in Puguang area is terrigenous clastic rock which is of low compositional maturity and high textural maturity. The average index of compositional maturity (quartz/feldspar+clastic debris) in Xujiache Formation is 1.27, with low content of quartz and high content of feldspar and clastic debris. Components in sandstone consist of clastic grains and matrix, and clastic grains contain quartz, feldspar and clastic debris (Table1).

3.2 Characteristic of clastic grains

(1) Quartz: the content of quartz in reservoir is generally between 47% and 62%, with average value of 53%. From T_{3x}^6 to T_{3x}^2 , the content of quartz increases, indicating that the hydrodynamic force was much stronger.

(2) Feldspar: the content of feldspar in reservoir is generally between 10% and 14%, with average value of 12.75%. As a whole the content of feldspar is low which is related to its corrosion.

(3) Clastic debris: sandstone in Puguang area is of complex clastic debris with high content. The content of clastic debris in T_{3x}^5 is the highest with the value of 43.6%, while that in T_{3x}^2 is the lowest with the value of 24.26%. And the main clastic debris is igneous rock, followed by metamorphic rock and sedimentary rock. The total content of clastic debris in T_{3x} is generally between 23% and 33%.

3.3 Architectural characteristic of reservoir sandstones

The grain size analysis of 85 sandstone samples in Xujiache Formation indicates that the main grain sizes are fine grain and medium grain whose contents are 37.3% and 35% respectively, followed by silt grain (21.5%) and coarse grain (6.2%) (Fig.2).

Table 1. The components statistical table of clastic rock in Xujiache Formation

Formation	Value	Components						
		Quartz	Feldspar	Clastic debris			Matrix	Cement Calcite
				Igneous rock	Metamorphic rock	Sedimentary rock		
T ₃ X ⁶	general	47-49	13-15	10-13	17-18	1-3	5-7	1-7
	min	47	11	10	15	0	3	0
	max	51	17	15	19	3	12	17
	average	48.5	14.4	11.8	17.3	0.5	4.18	4.5
T ₃ X ⁵	general	49-51	9-11	12-14	17-19	2-3	5-7	1-3
	min	48	9	11	15	0	3	0
	max	52	11	15	21	4	8	12
	average	50	10.1	13.2	18.1	1	5.8	2.4
T ₃ X ⁴	general	50-54	12-14	12-14	17-19	1-3	2-4	2-6
	min	48	11	8	14	0	0	0
	max	57	14	16	20	6	5	25
	average	52.38	12.52	13.19	17.76	1.86	2.71	5.19
T ₃ X ³	general	50-52	10-11	13-15	5-7	13-14	3-5	8-11
	min	49	10	10	5	5	0	1
	max	54	11	15	18	16	5	26
	average	51.2	10.8	13.4	8.4	11.8	3	11.2
T ₃ X ²	general	58-62	12-14	8-10	13-15	0-3	3-5	1-3
	min	56	11	7	6	0	1	0
	max	63	16	16	18	3	5	6
	average	60.31	13.56	9.87	13.74	0.22	3.48	1.56

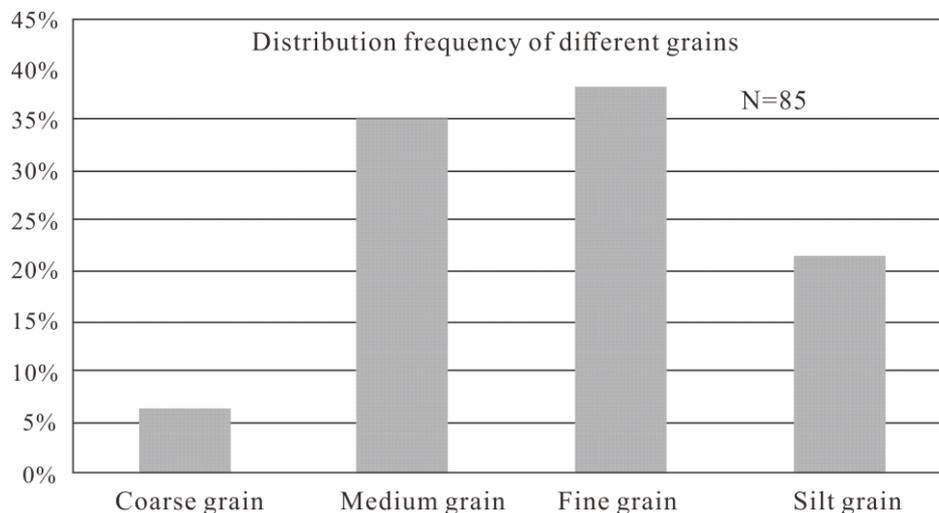


Fig.2 the histogram of grain size analysis of sandstone samples in Xujiache Formation

4. Reservoir physical property in Xujiache Formation

4.1 Characteristics of porosity and permeability

Analysis of cores in Well HZ1, PL1, PG3011-5, PG2, PG3 and PG4 indicates that the physical property of reservoir is poor (Table2).

Table2 the data statistical table of permeability and porosity of core analysis

Well name	Formation	Porosity			Permeability		
		Interval value	Average	Number of samples	Interval value	Average	Number of samples
HZ1	T _{3X}	0.34-6.65	2.26	181	0.004-15.85	0.114	118
PL1		0.1-7.8	1.8	269	0.023-0.844	0.045	269
PG3011-5		0.3-2.9	1.2	42	0.022-0.180	0.420	42
PG2		0.34-2.75	1.76	42	0.002-4.59	0.052	42
PG3		0.5-4.63	0.8	26	0.020-0.086	0.235	26
PG4		0.21-1.52	0.55	47	0.010-0.117	0.042	47

The porosity of 53.8% of the samples is less than 2%, that of 39% of the samples is between 2% and 4%, and that of only 7.2% of the samples is more than 4%. And the permeability of 28% of the samples is less than $0.02 \times 10^{-3} \mu\text{m}^2$, that of 67.5% of the samples is between $0.02 \times 10^{-3} \mu\text{m}^2$ and $0.1 \times 10^{-3} \mu\text{m}^2$, and that of only 4.5% of the samples is more than $0.1 \times 10^{-3} \mu\text{m}^2$, indicating that reservoir in Xujiahe Formation is of poor physical property.

Physical property analysis of 269 core samples in Well PL1 indicates that permeability and porosity are of positive correlation and the higher the porosity is the better than the permeability (Figure 4).

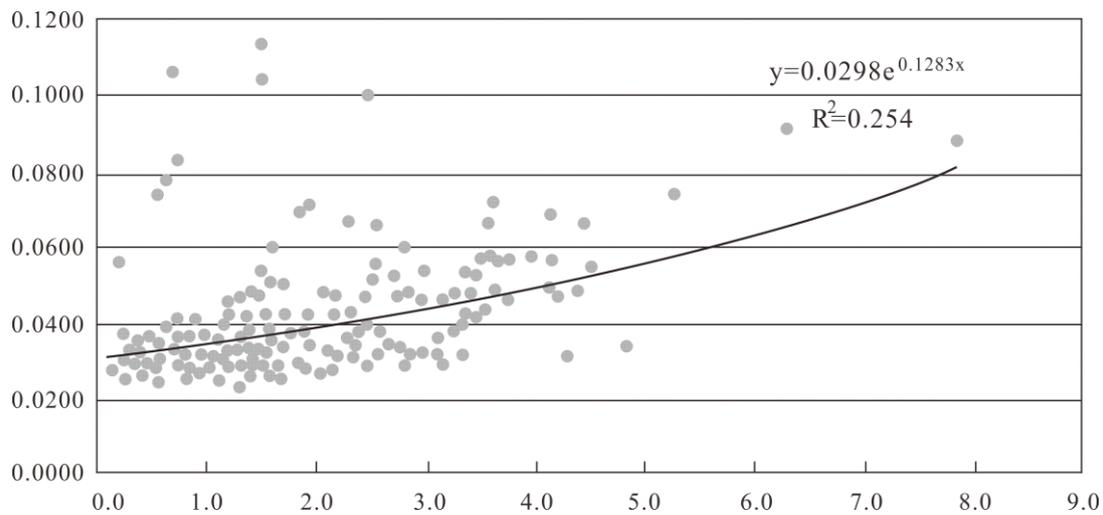


Fig.4 the correlation graph between the porosity and permeability (Well PL1)

Table3 the segmentation of physical property characteristic in the reservoir of Xujiahe Formation (Well PL1)

Formation	Number of samples	Porosity (%)	Permeability ($\times 10^{-3} \mu\text{m}^2$)
T _{3X} ⁶	83	2.07	0.042
T _{3X} ⁵	45	0.70	0.034
T _{3X} ⁴	63	1.55	0.049
T _{3X} ³	18	1.43	0.031
T _{3X} ²	60	2.51	0.056

4.2 Characteristics of reservoir physical property in different members

According to the physical property analysis of segmentation in Well PL1, it indicates that physical property of T_{3x}², T_{3x}⁴ and T_{3x}⁶ is of good porosity and permeability and much better than that of T_{3x}³ and T_{3x}⁵ (Table3).

5. Conclusion

(1) Reservoir of Xujiahe Formation in Puguang area is terrigenous clastic rock and of low compositional maturity and high textural maturity. And grain size of reservoir in Xujiahe Formation is mainly fine grain and medium grain.

(2) The reservoir porosity in Xujiahe Formation is generally less than 4% and the permeability is generally less than $0.1 \times 10^{-3} \mu\text{m}^2$ indicating that reservoir in Xujiahe Formation is of poor physical property. And physical property analysis indicates that permeability and porosity are of positive correlation and the higher the porosity is the better the permeability is.

(3) By characteristics analysis of reservoir physical property in different members, it suggests that physical property of T_{3x}², T_{3x}⁴ and T_{3x}⁶ is of good porosity and permeability and much better than that of T_{3x}³ and T_{3x}⁵, but the reservoirs are of low porosity and permeability or extra-low porosity and permeability.

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