

The tight reservoir microscopic classification of southern part of Qijia area in Songliao Basin

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Abstract. With the decreasing of the conventional oil and gas reserves, the unconventional tight oil and gas are gradually becoming the focus of the study. The casting thin section, conventional mercury injection, constant velocity and pressure mercury and other experimental methods, tight reservoir microscopic characteristics in southern part of Qijia area were studied in this paper. Based on the above conditions, combined with the parameters of pore type, pore throat radius, the reservoir is divided into two types, conventional reservoir and low permeability tight reservoir. Reservoir conventional reservoir permeability values are greater than 1mD, low permeability tight reservoirs are classified intoIIa type and IIb type, which provides some reference value for the actual exploration and development.

1. Introduction

The south region of Qijia is located in the north central depression of Songliao basin, which closed to the east of Xindian, to the west Daqing placanticline, Longhupao and to the south Xingshugang and to the north of Heiyupao sag (Fig.1). The objective area of this study is the Qingshankou formation of the Gaotaizi oil layer, the main reservoir is G3 and G4 reservoir group, which depth range between (1600~2300) m^[1-4]. This article represents the microscopic features by unconventional analytical test methods, such as casting thin sections and rate-controlled mercury penetration technique, and the reservoir is classified in the study area basing on that, which provides certain reference value for actual development and production.



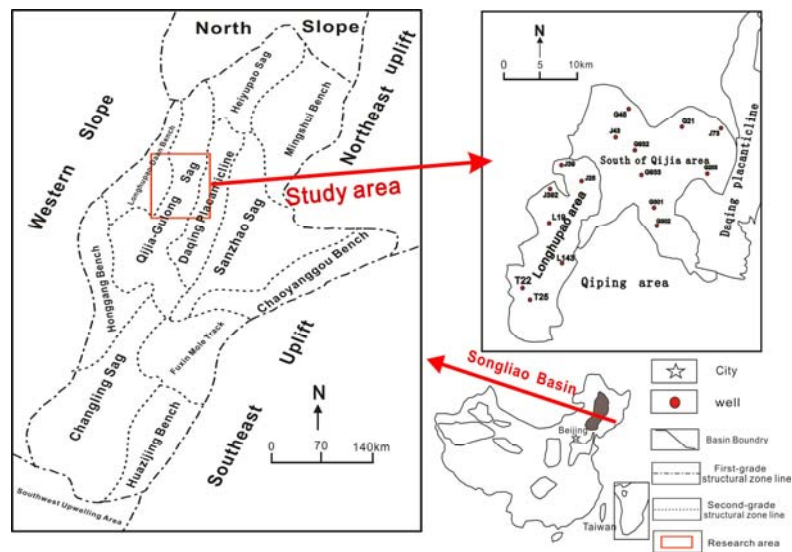


Fig. 1. Location of the study area

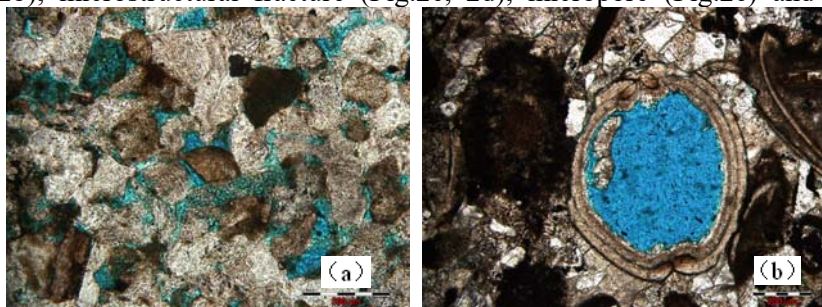
2. Reservoir characteristics

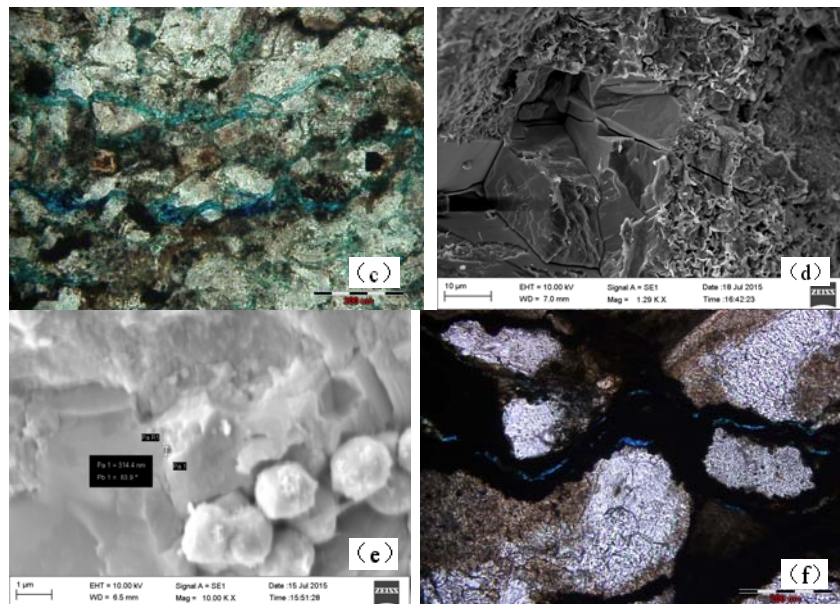
The results of whole rock analysis and rock slices identification of 732 samples in the study area show that the reservoir lithology is determined mainly as litharenite which has relatively low maturity, the diagenetic components are mainly quartz, feldspar and lithic fragment, followed by calcite. The porosity-permeability of 34 cored wells in the study area is measured by conventional mercury penetration and overburden measurement and so on, the porosity of the reservoir is between 2.5% and 21.3 % and the mean value is 11.08%, the porosity which is lower than 10% occupies 54% of the total, the permeability is between (0.01~96.5)mD and lower than 1mD occupies 89% of the totality, in conclusion, the objective reservoir in the study area is low permeability~ tight reservoir.

3. The characteristic of pore type and pore structure

3.1 Pore type

According to the analysis of experimental results of the description of casting thin sections and scanning electron microscope, the types of reservoir porosity in the study area are six kinds, includes intragranular dissolved pores(Fig.2a), intergranular dissolved pores(Fig.2a), dissolved pores of fossils(Fig.2b), microstructural fracture (Fig.2c, 2d), micropore (Fig.2e) and matrix pores(Fig.2f).





(a) G933 well, 2205.36m, intragranular and intergranular dissolved pores , plane-polarized light, $\times 20$;
 (b) G933 well, 2210.58m, ostracoda dissolved pores, plane-polarized, $\times 10$; (c) G9333 well,
 2296.04m, effective fracture, plane-polarized, $\times 10$; (d) G933 well, 2183.91m, microstructural fracture,
 scanning electron microscope; (e) J38 well, 2205.06m, micropore, scanning electron microscope; (f)
 J2 well, 1957.85m, matrix dissolved pores pore, plane-polarized light, $\times 20$.

Fig.2. The microscopic characteristics of Gaotaizi reservoir of southern part of Qijia area

3.2 Pore structure

Pore throat size and distribution were described clearly by constant-rate mercury injection experiment^[5], according to experimental measurement, data processing and so on, we found that the mean of the pore radius of the reservoir in the study area was between (131.39 ~ 148.99) μm , the mean is 140.16 μm ; The throat radius is between (0.16~24.52) μm , the means is 4.41 μm (Fig.3).

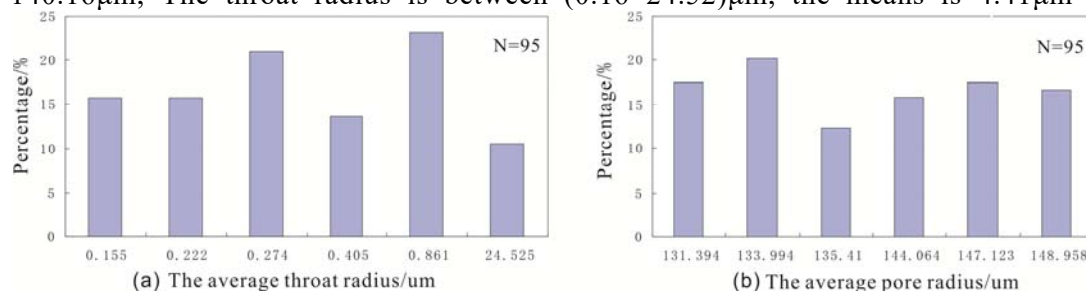


Fig. 3. The porosity and permeability radius of frequency of southern part of Qijia area

4. Reservoir classification

Synthesize various kinds of unconventional analysis test data, the reservoir pore type of the study area can be divided into two basic types: conventional reservoir and low permeability tight reservoir, porosity is more than 10% in the conventional reservoir (I type reservoir) and permeability is more than 1mD; the low permeability tight reservoir can be further divided into IIa type reservoir and IIb type reservoir, Different types of reservoir characteristics are as follows (Table 1):

I type reservoir: the porosity and permeability values are high, the pore radius is higher values, the pore connectivity is better and the displacement pressure is lower. It usually appears at submerged distributary channel, the dissolution is stronger and the cementation is weaker.

IIa type reservoir: The porosity and permeability are lower, The pore radius is low, the pore

connectivity is ordinary and the displacement pressure is higher. It usually appears at mouth bar, the dissolution is relatively weaker and the cementation is relatively stronger, a few void ruptures and ostracoda fossils appears .

Ilb type reservoir: The porosity is low and the permeability is very low. The pore radius is very low. The pore connectivity is bad and the displacement pressure is high, it usually appears at sheet sand, the dissolution is weak and the cementation is stronger.

Table 1 The classification of pore structure type of Gaotaizi reservoir of southern part of Qijia area

Reservoir classification	K/mD	Φ /%	Ra/ μ m	Rp/ μ m	Pcd/Mpa	Dm/ μ m	Sp	α	Smax	Number of samples
I	>1	17.6	8.36	3.31	0.076	2.12	2.84	0.37	61.26	15
Ila	1~0.1	9.37	1.15	0.28	14.53	0.22	2.72	0.28	59.33	9
Ilb	<0.1	8.5	0.22	0.07	36.42	0.04	2	0.32	42.29	12

Notes: K—permeability; Φ —porosity; Ra—the maximum of pore radius; Pcd—displacement pressure; Dm—mean radius; Sp—sorting coefficient; α —uniformity coefficient; Smax—the maximum of mercury injection saturation.

5. Conclusion

(1) G3 and G4 reservoir group of southern part of Qijia area is typical of low permeability ~ tight sandstone reservoir, the pore types of the study area includes intragranular dissolved pores, intergranular dissolved pores, dissolved pores of fossils, microstructural fracture, micropore and matrix pore, the average pore radius is 140.16 μ m, the mean radius of the throat is 4.41 μ m.

(2) Utilizing methods of conventional and unconventional research techniques and according to the relative microscopic feature parameters, the pore structure type of the reservoir in the study area is divided into three basic types: conventional reservoir and low permeability tight reservoir, the type reservoir is conventional reservoir, the low permeability tight reservoir can be further divided into Ila type reservoir and Ilb type reservoir .

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