Volcanic Rock Diagenesis and Characteristics Analysis of Reservoir Space of Yingcheng Formation in Yaoshen 2_3 Well Area

Jing Jun Zhang, Xian Jun Ren, and Cheng Zhi Liu

***Abstract*—Research on volcanic rock diagenesis has important reference value in volcanic rock secondary pore formation, evolution and reservoir prediction. Using the core data, flakes, imaging logging, geochemical analysis and lithologies-lithofacies characteristics of Yaoshen 2_3 well area in Yingcheng Formation, Changling fault depression, we research on the volcanic rock diagenesis, reservoir space types, characteristics and relationships. The results are shown that: The research area mainly develop volcanic rock mantle thermal liquid alkali metasomatism and other 10 diagenesis types, and base on diagenesis formation mechanism and the effects of the reservoir spaces, which is divided constructive and destructive; The primary, secondary and composite pore types are all developed, base on the diagenetic stages, combination of porosity-fracture, which is identified further 12 types, almond body residual pore, matrix pore, intergranular pore-dissolved pore and suture fracture develop best; Volcanic rock diagenesis complexity are the main control factors of complexity and diversity in reservoir space types.**

***Index Terms*—Yaoshen 2_3 well area, yingcheng formation, volcanic rock, diagenesis.**

I. Introduction

Yaoshen 2_3 well area are in the Yaoyingtai structure, Chaganghua sub-depression, Changling faulted depression, Songliao Basin central depression. By Daerhan fracture control, which are lithologic volcanic rock oil and gas reservoirs with the slope structure, Yingcheng Formation deep volcanic rock the main natural gas exploratory reservoir. Volcanic rock reservoirs lithology develop mainly into lava and volcanic clastic rock, 15 rock types [1], [2].Yaoshen 1, 2, 3 wells obtained high yield industrial gas flow in Yingcheng formation volcanic rock, thus reveal that the faulted layer have rich resources, the great exploration potential and good natural gas prospect in Songnan gas field[3]-[5]. However, the volcanic rock reservoir in Yingcheng Formation show strong heterogeneity, pores, fractures and other complex and diversity characteristics [6]-[8], these restrict the gas reservoir depth development and well deployment. Making clearly reservoir development characteristics and influence factors have been put forward, this research will give the key analysis on reservoir development characteristics, diagenesis and effect on the effect of the reservoir space of volcanic rock in Yingcheng formation, to understand the effect to gas reservoir forming and distribution of gas and water of reservoir space types, characteristics, distribution and understand the action of diagenesis during formation and evolution of the reservoir space . For the next step research on reservoir distribution, distribution of gas reservoirs, gas water relations and other aspects, provide a solid foundation and reference.

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II. Volcanic Rock Diagenesis Types and Characteristics

Volcanic rock diagenesis can be divided into constructive and destructive diagenesis according to its contribution to volcanic rock reservoir. The constructive diagenesis can form primary, secondary pore, fracture, which can improve reservoir porosity and permeability, thus form favorable volcanic rock reservoir. The constructive diagenesis is main condensation and contraction, dissolution, metasomatism, weathering, tectonism and devitrification;

Destructive diagenesis is adverse on the formation and preservation of primary pore, fracture, which destroy formation and development of the original pore and fracture, reduce porosity and permeability of the reservoir and develop adversely on the reservoir, which is mainly 3 types of melting and magma cementation, compaction and pressure solution, filling effect [9]-[13].

III. Reservoir Space Types and Characteristics

Volcanic rock reservoir of Yaoshen 2_3 well area in Yingcheng formation has the characteristics of strong heterogeneity, varied reservoir space types, complex pore-fracture structure, strong influent of secondary effect, which secondary porosity superimposes on the primary reservoir space and form reservoir space of complex pore-fracture combination types. By the better pore-fracture combination, primary and secondary pore, fracture and playing a good connectivity, seepage of volcanic rock reservoir space, we can obtain conclusions that volcanic rock reservoir of Yaoshen 2_3 well area in Yingcheng formation can be divided into pore type, fracture type and composite pore-fracture type. Thin section analysis is shown that volcanic rock of Yingcheng formation secondary pore develop, among them, dissolution pore-fracture, contraction fracture, seaming fracture, almond body residual hole, large pore, elongate dissolution pore develop[14]-[15].

A. Primary Pore, Fracture Characteristics

Almond body residual hole is common reservoir space of

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volcanic lava reservoir, mainly in rhyolitic crystal ignimbrite. It often connect with original diagenetic fracture, later secondary weathering fracture and structural fracture, form variety of pore-fracture combination types, which constitute extremely important reservoir space and enhance the reservoir properties in the volcanic rock(Fig. 1_A).

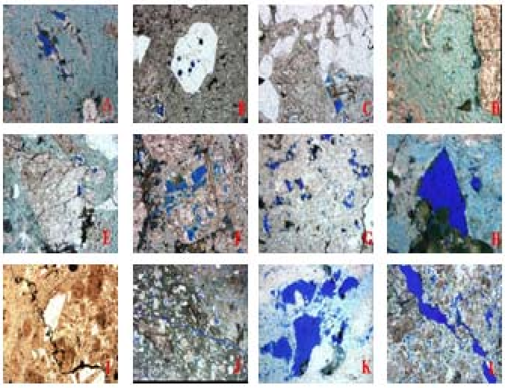

Fig. 1 .Yingcheng formation volcanic rock porosity types and characteristics **A**. Almond body residual hole, rhyolitic crystal ignimbrite, Yaoshen 3well,3529.2m,20×10(-); **B.** Rhyolitic ignimbrite,Yaoshen 2 well, 3764.8 m,4×10(-); **C.** Intergranular pore, rhyolitic ignimbrite,Yaoshen 2 well,3761.7m, 10×10(-); **D.** Matrix microspore, rhyolitic crystal ignimbrite,Yaoshen 3 well, 3529.2 m,20×10(-);**E.** Burst fracture, the iron filling, rhyolitic crystal ignimbrite, Yaoshen 301 well，3738.5 m,4×10; **F.** Dissolution pore in feldspar phenocrysts, rhyolitic crystal ignimbrite,Yaoshen 3 well,3529.05 m，10×10,(-); **G.** Matrix solution pore, rhyolitic ignimbrite,Yaoshen 2 well,3764.8m,10×10,(-);**H.** Feldspar moldic pore, rhyolitic crystal ignimbrite，Yaoshen 3 well，3529.2 m,20×10,(-); **I.** Steaming fracture green mud filling, rhyolitic crystal ignimbrite，Yaoshen 202 well,3733.95m,4×10,(-); **J**. Dissolution fracture, rhyolitic crystal ignimbrite，Yaoshen 301 well，3859.9m，1.25×10, (-) ; **K.** Dissolution expansive pore, rhyolitic crystal ignimbrite,Yaoshen 301 well,3737.3 m,10×10,(-); **L.** Elongate hole, rhyolitic crystal ignimbrite,Yaoshen 301 well,3859.5 m,4×10,(-).

Fused pores in phenocrysts mainly developed in the volcanic breccias lava, welded volcanic breccias and ignimbrite. These pores are generally smaller and more are filled with magma matrix, size is generally less than 0.1mm. Overall development is few and isolated relatively, so they have no actual contribution to the reservoir (Fig. 1_B).

Intergranular (gravel) pores distribute in the volcanic clastic particles, which are retained pores in volcanic clastic particles after volcanic clastic particles diagenesis, due to the later diagenesis influence, intergranular pores often produce dissolution phenomenon and form dissolution fractures and expansive pores (Fig. 1_C).

Micropores can be divided into intergranular pores and matrix micropores. Intergranular pores are mainly distributed in the basalt and matrix pores are in tuffs, tuff volcanic breccias contented high fine volcanic clastic materials (Fig. 1_D). The contribution of microporous reservoir space is very small, but the distribution is more common.

Burst fractures are detrital material carried by magma in volcanic eruption explosion form the fracture, which are developed in volcanics (Fig. 1_E).

B. Secondary Pore, Fracture Characteristics

In secondary porosity of the area, solution porosity is the most development which is also the widest distribution and the most important reservoir space type of volcanic rock; Seaming and dissolution facture are main in secondary fracture.

Intragranular dissolved pore develop mainly in the basalt, welded breccias, breccias lava, volcanic agglomerate and volcanic breccias, followed in tuff, sed volcanic pyroclastic rock (Fig. 1_F).

Moldic pore form of feldspar, olivine and other minerals all dissolved away (Fig. 1_G).

Matrix dissolution pore: According to the core data and cast thin section observation, matrix dissolution pore develop generally, which develop mainly in the basalt, glass matrix of basaltic autoclastic volcanic breccias, fine volcanic clastic rock of breccias lava and volcanic breccia, volcanic ash of tuff(Fig. 1_H).

Seaming fracture: Form of cutting lava phenocrysts, matrix and volcanic clastic rocks, its prominent characteristics are serrated, between the seams filling full or partial of iron and clay, no filling fracture is less（Fig. 1_I).

Dissolution fracture: Materials between volcanic breccias are dissolved and form of secondary fractures, materials in volcanic breccia develop dissolution and form intragranular dissolution fracture (Fig. 1_J).

C. Composite Pore Combination Types

Large pore is pore volume over the neighboring particle pores, which is also called super pore. It is formed that the soluble components in intergranular pore are dissolved (Fig. 1_K).

Elongate dissolution pore is large pore; it is formed of dissolution with elongate, pore wall across multiple volcanic clastic rocks (Fig. 1_L).

IV. Influence of Volcanic Rock Reservoir Diagenesis on Reservoir Space Evolution

A. Diagenetic Environment

The syndiagenetic environment: The types of the environment include condensation (cooling) contraction, magma cementation, volcanic hydrothermal filling effect, etc... The main reservoir space types of the phase are condensing and contractive fracture, burst fracture, volcanic breccias pore, matrix micropore.

Burial diagenetic environment: Compaction, dissolution, metasomatism, filling effect and devitrification etc. develop mainly in burial diagenetic environment. Main reservoir space types developed in the phase are varied secondary pores formed of the dissolution, intercrystalline pores formed of devitrification, structural fracture and diagenetic fracture.

Supergene diagenetic environment: Dissolution, filling effect, weathering, tectonism and devitrification developed mainly in the supergene diagenetic environment. Main reservoir space types formed in the phase are weathering fracture and leaching dissolution pores formed by weathering, structural fractures formed tectonism, intergranular pores formed by devitrification (ChengZhi Liu, 2010; PuJun Wang, 2008).

B. Rock Pores Formation and Evolution of Different Types

Reservoir space characteristics in different rocks are differences. These causes by that formation and evolution of porosity in different types rocks are different.

Volcanic clastic rock pores formation and evolution: volcanic clastic rock have better property, these are decided by volcanic clastic rock porosity formation and evolution characteristics. Main diagenesis types with destructive role are welded effect, compaction, pressure solution, filling effect etc. These effects can cause the rock to become dense, smaller porosity, reduce the porosity and permeability of rock; Constructive role are dissolution, tectonism, weathering and devitrification, these roles increase rock pores and improve the porosity and permeability of rock; Metasomatism have little effect to volcanic clastic rock porosity formation and evolution.

Lava pore formation and evolution: Diagenesis types during the rhyolite diagenetic evolution processes include condensation (cooling) and contraction, dissolution, metasomatism, filling effect, structural effect, weathering and devitrification etc. Main diagenesis types with destructive role to porosity formation and evolution are filling effect; Constructive roles are main condensation(cooling) and contraction, dissolution, tectonism, weathering and devitrification; Metasomatism have little effect to volcanic lava pore formation and evolution.

Volcanic breccia lava(rhyolitic volcanic breccia lava): Volcanic breccia lava is a rock type between lava and volcanic clastic rock , which have properties of lava and volcanic clastic rock, in addition which can be dissolved more objects, this determine that dissolution is relatively strong in the diagenetic evolution process, so it has high porosity and better permeability.

V. Conclusions

Volcanic rock diagenesis can be divided into constructive diagenesis and destructive diagenesis. The diagenesis of Yingcheng formation all identifies 10 types in Yaoshen 2_3 well area. Constructive diagenesis include condensation and contraction, dissolution, weathering, dissolution, tectonism, devitrification etc.; Destructive diagenesis include welded effect and magma cementation, compaction and pressure solution, metasomatism, filling effect etc.

Volcanic rock reservoir space types are divided into 2 categories(primary pore and fracture, secondary pore and fracture) and 3 types(primary pore and fracture, secondary pore and fracture and composite pore and fracture)according to the formation stages ; The pore is divided into primary pore, secondary pore and composite pore, which is further divided into 9 types according to the structure, the most primary pore is almond body residual hole, matrix micropore, intergranular pores, intragranular dissolved pore; The fractures are divided into the primary fracture and secondary fracture, according to the structure which is further divided into 3 kinds, seaming fracture is the most primary type.

Volcanic rock diagenetic stage is divided into the co genetic diagenetic stage, early burial diagenetic stage, later burial diagenetic stage and supergene diagenetic stage. And the corresponding diagenetic environment are atmospheric freshwater diagenetic environment, shallow buried atmospheric freshwater and groundwater diagenetic environment, mid-deep buried groundwater and deep buried hydrocarbon alkali fluid and organic acidic water diagenetic environment, exposed surface atmospheric freshwater diagenetic environment.

Different diagenetic stages and diagenetic effects from different reservoir space and the development degree, which are the main control factors of reservoir space types and developmental characteristics.

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