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Volcanic Facies Distribution in Haerjiawu Formation of Santanghu Basin

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Abstract: Santanghu basin has made a breakthrough In Volcanic exploration, submitted a large oil and gas reserves, but the volcanic reservoirs in the formation of a complicated process influenced by many factors, the study is relatively weak. Using the core observation, thin section analysis, well logs and seismic data analysis, comprehensive study of the reservoir characteristics and the volcanic lithofacies types: there are explosive facies, effusive facies, volcanic sedimentary facies, and extrusive facies, volcanic vent facies which we can identify from the seismic. Meanwhile, we also discussed the distribution of volcanic lithofacies that has great significance for oil and gas exploration.

Key words: *Santanghu basin, volcanic rocks, volcanic lithofacies type.*

I. INTRODUCTION

Santanghu basin is one of the foreland basins in Xinjiang province of China, has experienced multi-stages of tectonic evolution. It was learned in recent years that several oil-bearing formations were found in Jurassic, Triassic, Permian and Carboniferous of the basin, especially the large-scale volcanic rock reservoirs were found in Carboniferous strata since 2006, which created a new situation for oil and gas exploration in Santanghu Basin. Volcanic lithofacies, as one of the most important factor of volcanic reservoir evaluation, which not only control the distribution of effective reservoirs, but also have a direct impact on reservoir physical properties and oil productivity. Therefore, the study on volcanic lithofacies distribution is of great significance for oil and gas exploration.

II. THE VOLCANIC LITHOFACIES TYPE

According to the principles of volcanic lithofacies division combined with the comprehensive utilization of core observation, thin sections and logging data in the work area, three facies can be identified as follows: explosive facies, effusive facies and volcanic sedimentary facies. Another two facies, volcanic vent facies and extrusive facies can be identified by the characteristics of seismic data. Further more, the volcanic lithofacies of Haerjiawu formations can be divided into five facies and nine subfacies.

1.1 Explosive facies

Explosive facies is mainly distributed in the early period of volcanic eruption, characterized by tuff and volcanic breccia, and transit from volcanic breccia to tuff gradually, which can be divided into three subfacies, fall deposits subfacies, surge subfacies and Pyroclastic flow subfacies[1-2].

In the Santanghu Basin, the main lithology of the explosive facies is volcano breccia and tuff, mixed with volcanic agglomerate and welded pyroclastic rocks, which are characterized by high eruption temperature and viscosity, containing more volatile composition and the thickness and composition are unstable.

1.1.1 Fall deposits subfacies

The fall deposits subfacies mainly composed of agglomerate, volcanic breccia and crystal tuff. The rocks of fall deposits subfacies are characterized by agglomerate texture, volcanic breccia and tuff texture, the grain of which shows a positive rhythm, and is both particle supported and matrix supported. The main cementation type is porous cementation, followed by basal cementation and occasionally contact cementation. The air fall subphase is formed by solid volcanic debris and plastic ejecta suffered volcanic gas injection in the process of eruption, finally fell to the earth surface and experienced the compaction, which always seen in the lower explosive facies and the particle size become finer upwards, intercalary strata sometimes appeared(Fig.1, a).

1.1.2 Pyroclastic flow subfacies

The lithology of pyroclastic flow subfacies mainly contain crystal fragments, vitric fragments, magma fragments, debris and welded breccia, the texture of which includes welded tuff texture, welded breccia texture and pyroclastic texture, supported by matrixes and have a normal graded bed sequence with blocky structure. It

is actually the mixture of volatile burning debris and magma fragments, flowing drived by subsequent ejecta and its own gravity. It is always in the upper of explosive facies, formed by the cementation of cooling magma and compaction(Fig.1, b).

1.1.3 Surge subfacies

The main lithology of surge subfacies is tuff containing crystal fragments, vitric fragments and magma fragments, showing a volcanic clastic texture, and the crystal tuff texture is most extensive. The rocks formed by the gas - solid - liquid multiphase system injected by the gas moving as suspended load near the earth surface, finally compacted into rocks, show a massive structure and normal graded bed sequence.

Surge subfacies usually at the middle-low part of explosive facies. From bottom to top, the size of tephra becomes smaller and the thickness of layers becomes thinner or results alterations with air fall subfacies. In the work area, tuff is the most widespread rock.

1.2 effusive facies

The effusive facies developed most extensive in Carboniferous volcanic reservoir and it is almost basalt and andesite, which has the characteristics of high eruption temperature, low-middle viscosity, relatively stable thickness and composition[3].

1.2.1 Lower subfacies of effusive facies

The representative lithology of lower subfacies are syngenetic brecciated basalt and breccia andesite, which have a porphyritic and brecciated texture, and with a massive and stomatal amygdaloidal structure, and the almonds filled by chalcedony, calcite filling was saw in the lower part of the flow unit and is visible. The primary pores in lower subfacies of effusive facies developed well, because of strong brittleness of rocks, the fractures are easy to be formed and preserved. Beyond these, breccia pores between rubbles, dissolution pores and tectonic fractures are developed.

1.2.2 Middle subfacies of effusive facies

The represent rocks of middle subfacies are basalt and andesite, which showed a volcanic breccia texture, porphyritic texture and interleaving texture with massive structure and flow structure located in the middle part of the flow unit. Interlayer fractures, dissolution pores and tectonic fractures are all developed in this subfacies but just a little .The pores distributed uniformly but tight(Fig.1 c).

1.2.1 Upper subfacies of effusive facies

The representative rocks of upper subfacies are broken volcanic breccia, vesicular basalt and vesicular andesite. The pores of this subfacies show a belted distribution, stretching along flow direction. The porphyritic texture, brecciated texture, massive and stomatal amygdaloidal structure located in the upper part of the flow unit. The location of primary pores developed widest, which are connected by tectonic fissures. Influenced by the vesicle, the residual pores, dissolution pores and tectonic fractures in upper subfacies present for irregular fractures between pores, while lack of ganged fractures. The upper subfacies of effusive facies is always one of lithofacies zone with best reservoir property.

1.3 volcanic sedimentary facies

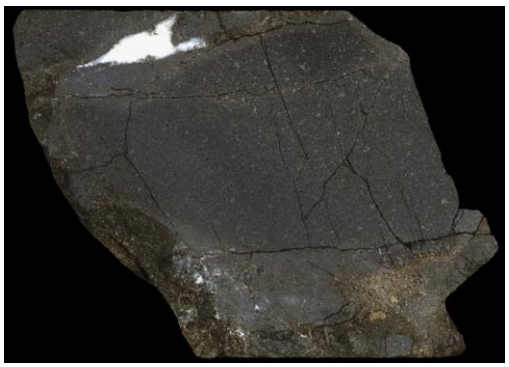
The representative lithology of volcanic sedimentary facies includes sedimentary volcanic breccia (tuff). The representative lithology of pyroclastic sedimentary rock subfacies that contain epiclast includes sedimentary pyroclastic rocks containing terrigenous clasts, and the secondary transportation pyroclastic sedimentary rocks is sedimentary pyroclastic rock[4-5]

The secondary transportation pyroclastic sedimentary rocks subfacies

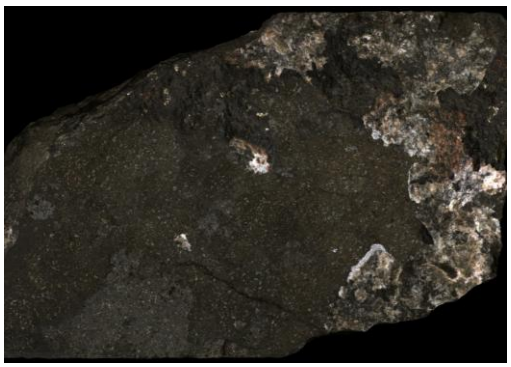
This kind of phase almost lies in the low-lying areas between the volcanic domes, the representative rocks of which are layered pyroclastic rock and sedimentary tuff, which formed by the pyroclastic tephra compacted after deformation of flowing water. It contains terrigenous clastics texture and cross bedding, trough cross beddings and massive structure or other structural features. It can be learned by microscope identification that the lithology of secondary transportation pyroclastic sedimentary rocks subfacies mostly is secondary volcanic breccias(Fig1. d).

Pyroclastic sedimentary rock subfacies containing epiclast

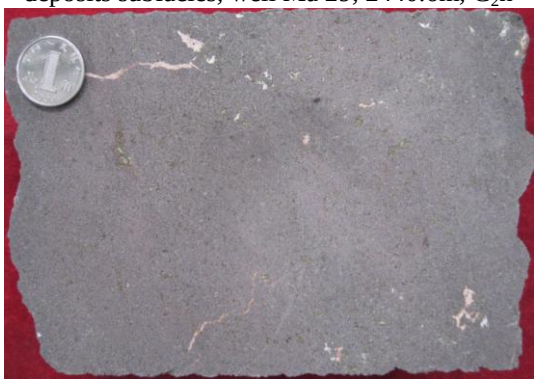
It usually located in the low areas between the volcano domes, the representative rock of which is volcanic tuffaceous glutenite, which formed by the tephra within terrigenous detritals compacted into rocks, showing a terrigenous clast texture and cross-bedding, groove bedding and massive structure in this subphase(Fig.1 e).



(a) gray basaltic volcano agglomerate, fall deposits subfacies, well Ma 29, 2440.6m, C_2h

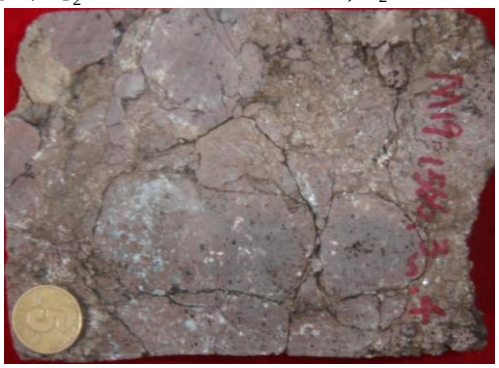


(b) Basaltic volcanic rock, Pyroclastic flow subfacies, well Ma 45, 2485.7m, C_2h



(c) Grey green tuff, well Ma21, 2047.76-2048.26m， C_2h

(d) Gray green basaltic tuff, well Niu9-10, 1565.9m, C_2h



(e) Dark red andesitic sedimentary volcanic breccias, well Ma 19, 1566.3m, C_2h

Fig.1 Typical volcanic facies photos in Santanghu Basin

III. SEISMIC REFLECTION CHARACTERISTICS OF VOLCANIC LITHOFACIES

2.1 Explosive facies

Explosive facies are mainly distributed in the early period of volcanic eruption, the primary rocks are tuff and volcanic breccia, always show a shape of mound on the seismic section, interior is littery and reflected stronger on the top and weaker internally (Fig. 2 a).

2.2 Effusive facies

Effusive facies is formed in the middle period of volcanic eruption cycle, it generated by the gradually cooling magma containing crystallographic minerals and synchronogenic rubbles drived by subsequent ejection and its own gravity in the process of flowing along earth surface. The effusive facies in the work area can be divided into lower subfacies, middle subfacies and upper subfacies and appears into meso-volcanic rocks and basic volcanic rocks, which indicates a middle-strong reflection, discontinuous continuity, wedge shaped texture and heterotrophic structure (Fig.2.b).

2.3 Volcanic sedimentary facies

Volcanic sedimentary facies often grew with volcanic rocks, it could appeared in any periods of volcanic activity, especially in the late of eruption cycles or eruption issues. Volcanic sedimentary facies located in the low-lying areas between different volcanic vents, containing a lot of volcanic fragments in the detrital composition, mainly are clastic sedimentary bodies between volcanic domes. In the seismic section, volcanic

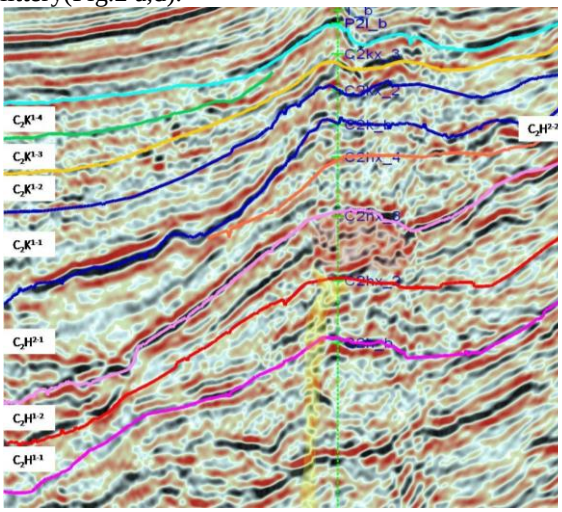
sedimentary facies shows a strong lineups, good continuity, stable waveform, and strong continuous reflection (Fig.2 c).

2.4 Extrusive facies.

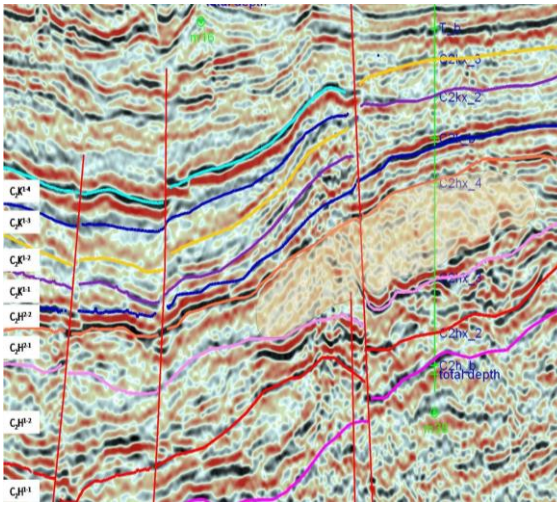
Extrusive facies is in the late stage of volcano activity cycle, most of its appearances like a dome. Extrusive facie located in the upper part of volcanic vents, in the seismic profile it shows an uncontinuous reflection, the lineups spreads to outside like a fan with bottom as its center. The shape of reflection events likes an umbrella, with erect lineups and indicate discontinuous unparallel unsmooth horizontally. (Fig.2 d).

2.5 Volcanic vent facies

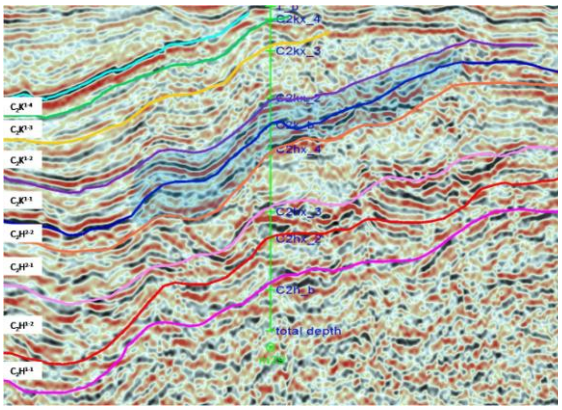
The volcanic vent facies is in the low position of the volcanic edifice, forming at the same period of the volcano cycle or after it. This kind of volcanic phase contains many kinds of volcanic rocks with different lithology, structure and color mixed with volcanic breccia. The boundaries of different rocks are clear. In the seismic profile you can see it under in the cone like an erect cylinder, the reflection of which is discontinuous and littery(Fig.2 a,d).



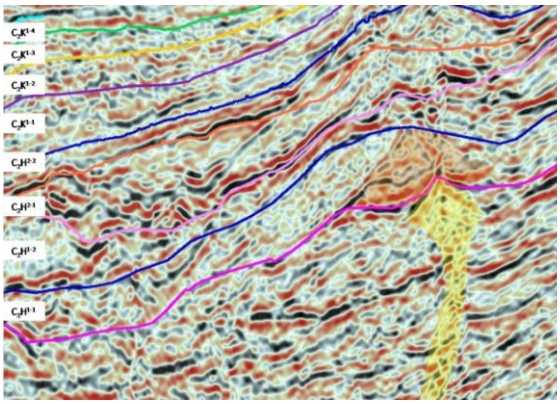
(a) Explosive facies and Volcanic vent facies, well Ma 17



(b) effusive facies, well Ma 38.



(c) volcanic sedimentary facies, well Ma 29.



(d) Extrusive facies , Line 1664

Fig.2 Typical Seismic reflection characteristics in Santanghu Basin

IV. VOLCANO FACIES PLANE DISTRIBUTION

According to the analysis to structure, stratum thickness and single well lithofacies combined with seismic data, we drew the volcanic lithofacies distribution maps of Haerjiawu formation in Malang depression by means of building a congruent relationship between geology and seism.

In this stage, explosive facies and the volcano channel primarily in the northwest part while nearly no extrusive effusive facies. The volcano facies in the work area develops seperated.It can be clearly seen that it isrelatively calm during the volcano period with large amount of lava overflowing, a little volcano clastic. All in all, it can be concluded that the study area is at the beginning of the volcano cycle.

V. CONCLUSION

1、Five facies and nine subfaices can be distinguished in the work area as followed. Explosive facies, effusive facies, volcanic sedimentary facies, extrusive facies and volcanic vent facies.

2, Drilling can only reveal explosive facies, effusive facies and volcanic sedimentary facies.
3, According to the seismic facies features of Carboniferous in Malang sag, the volcanic reservoir facies of volcanic reservoir are divided: explosive facies, effusive facies, volcanic sedimentary facies, volcanic vent facies and extrusive facies.
4, The Carboniferous volcanic craters distribute along the fracture showing a belt or beads shape, the magma erupted to earth surface from the fractures and cracks calmly as overflow and formed a extensive shield volcano with wide top surface and slope flanking.

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