IOSR Journal of Engineering (IOSRJEN) **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719
Vol. 05, Issue 04 (April. 2015), ||V2|| PP 55-58

Volcanic rock facies prediction in Yingcheng Formation based on seismic attributes, Yingshan depression

Yushuang Hu [1], Shiqin Zhang [1], Mingxue Zhang ,[1]Zhiming Zhang [1]
1. Northeast Petroleum University, Daqing, Heilongjiang, China, 163318

Abstract: - By using Shuangcheng city's high resolution seismic data, logging data, combining with the single well facies and al well phase division, application of coherence detection technology and waveform clustering seismic facies analysis technique, respectively, to identify the crater and proximal facies and far source group the main boundary and volcanic sedimentary facies, using square amplitude attributes, amplitude changes attributes refines facies boundary and facies type, and combining the core lithology and logging, seismic, single-well lithology profile data for validation, effective camp in shuangcheng city group volcanic rocks favorable area is forecasted.

Keywords: - *Amplitude attribute, Seismic attributes, Seismic coherence, Volcanic facies, Waveform clustering*

I. INTRODUCTION

In recent decades, volcanic rock reservoirs caused the attention of many experts at home and abroad as an important part of the unconventional reservoirs, volcanic facies distribution were determined by seismic attribute characteristics become the focus of common research. Volcanic rock facies has strong heterogeneity, many volcanic eruption types, complex volcanic rock facies and phase sequence, and the nonhomologous volcanic superimposed phenomenon is widespread, so patterns of volcanic eruptions and distribution law of volcanic rock facies's research are also difficult[1]. the study of volcanic facies and division has a number of different understanding by Chinese and foreign geologists, Fisher and Schmincke believe that volcanic clastic rock can be divided into pyroclastic flow facies, volcanic erupt clastic facies, fluvial facies and ash flow faces; according to volcanic material handling methods, Jin Bolu said 11 subfacies can be divided into 4 phases, including eruption facies, spray collapse and eruption facies, leaching and subvolcano facies and eruption sedimentary facies; Liu Xiang maintained volcanic clastic rock can be divided into 4 kinds of lithofacies, air landing debris including volcanic eruption, volcanic debris flow deposits, lahar debris, volcanic base surge deposit; In 2003, Wang Pujun insisted volcanic facies could be divided into eruption facies, intrusive facies, etc leaching 5 phase 15 subfacies and successfully applied in Songliao basin[2-4]. Predecessors' research, volcanic rock facies prediction used to predict distribution of favorable reservoir and optimize exploration target.

In 2011, Chen Changle[5] summarizes the use of local seismic attributes to identify volcanic rock, through calculating the local frequency of seismic profiles, draw the low frequency area, and on the same section curvature circle high curvature calculation value, superimposed after identification of volcanic rock distribution area. In 2014, Zhou Tianqi used seismic reflection characteristics, such as amplitude seismic attribute, the frequency information, and drilling data to identify the volcanic rock, so as to enhance the accuracy of the prediction[6].

In this paper, combine with previous studies in the study of volcanic distribution characteristics and the volcanic facies boundary, make full use of coherence detection technology, the waveform amplitude attribute clustering analysis technology and amplitude attribute to analysis seismic facies of volcanic rock, then combine with seismic profile analysis to identify a more accurate favorable results.

II. REGIONAL GEOLOGICAL SURVEY

Warbler sag is in deep depression area of the Shuangcheng fault depression, it is the area of 1661 square kilometers. During the period of the Yingcheng formation deposit, the fault activities in Shuangcheng fault depression are intense and a lot of magma upwelling along the fracture result in widely distribution of volcanic rocks. Because of the development of eruption facies around crater, crater turn into top of local structure, leading to the direction of the advantages of gas migration; Near the crater is micro fracture and fracture development zone with strong seepage ability. Volcanic cone is usually near the deep fractures, and deep fracture communicate gas source and reservoir, then volcanic cone become good channel of gas migration , so volcanic agencies are often natural gas enrichment zone.

Yingcheng formation of Yingshan depression volcanic rocks have large thickness, development of the overflow and the outbreak of phase, large porosity, and good reservoir capacity, in addition, Yingcheng formation volcanic rocks are directly covered in Shahezi Formation hydrocarbon source rocks, and have good reservoir space matching relation.

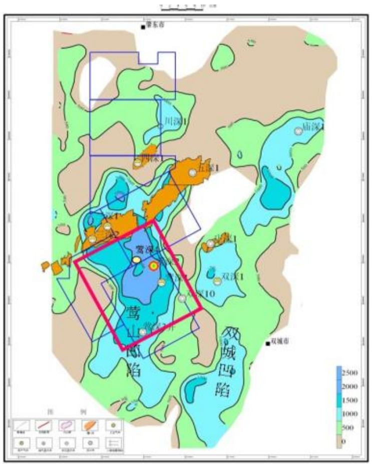

Fig 1 structural framework of Shuangcheng depression

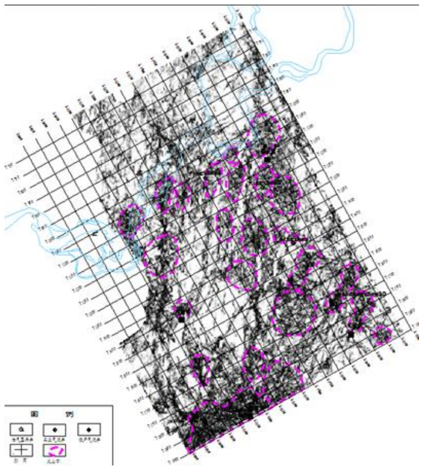

Fig2-1 crater prediction in stage 3of Yingshan area

III. COHERENCE METHOD TO IDENTIFY THE CRATER

This article is based on research by professor Wang Pujun who research volcanic rock in Xujiaweizi proposed based on "Lithology - Fabric - Causes," the division method. It is mainly based on lithology, the volcanic eruption phase is divided into 5 categories, including eruption phase, effusive phase, intrusive facies, volcanic channel phase and volcanic sedimentary facies. According to the characters of volcanic rock formation in Ying Shan depression, In the same process of volcanism, spatial distribution of volcanism product output characteristics included crater - near crater facies, proximal facies group, far source facies, volcanic sedimentary facies group (group handling and mixed phase), each phase group on the spatial location, lithologic combination, seismic characteristics have bigger difference, reservoir capacity difference is also big.

Three-dimensional coherent cube technology is the use of 3 d seismic cube in the similarity of seismic signals between adjacent channels to describe the lateral heterogeneity of strata, lithology. The crater with the ring, the radial structure, shows weak coherent, messy reflection insider on the coherence of coherent.

Figure 2-1, it can be seen that large numbers of crater distributed widely along the fault zone and fracture cross parts distribution in stage 3, and we can find crater distributed near 5 Wells, which is a zonal distribution near the YS2 Wells from north to south, but in the middle of the YS3 well to YS2 well area, coherence is good, and there are almost no crater.

IV. SEISMIC FACIES BOUNDARY PREDICTION

4.1 Waveform clustering analysis to predict seismic facies boundaries

The change of any physical parameters of seismic signal is always correspond to reflect changes in the shape of seismic trace. Waveform clustering property principle mainly is to assume that any physical parameters of sedimentary strata changes are always reflected in the change of seismic wave shape. Waveform clustering property classification process is based on the shape of the seismic trace and convert seismic data sample point value changes into the change of the shape of seismic trace, the size of the amplitude value for seismic trace overall shape change is not very important. Waveform clustering attribute be divided into several kinds of typical shape, each actual seismic trace corresponds to the shape of a model a very similar way.

By observing distribution of the color on the drawing, and through the assessing that the seismic shape in interpreting the regional distribution. By putting log facies information projection to the seismic and well information changes corresponding to the seismic, in accordance with the waveform characteristics of the location of each well endowed with a certain color, check the single well and seismic facies model corresponding relation, then we can know the interpretation of the sedimentary facies.

Purpose layer of volcanic rocks can be divided into six stages, volcanic rock system is shown in figure 3-2. To the third stage as an example, the waveform clustering attribute graph (figure 3-1) blue area of the crater - close to the volcano group, which mainly distributed in south and mid-east, accounting for more than half of the study area. The crater –near crater group usually correspond with volcanic conduit facies, extrusive facies and erupting facies. Distal facies group is in the northern edge of golden area development phase group, and it is a layered distribution on seismic section, and it is corresponded with the heat wave base and fine clastic empty fall subfacies of eruption facies. Brick red area is discontinuous layer on seismic profiles, which shows the proximal facies groups, and it corresponds to the pyroclastic lava flow subfacies of the eruptive facies and effusive facies.

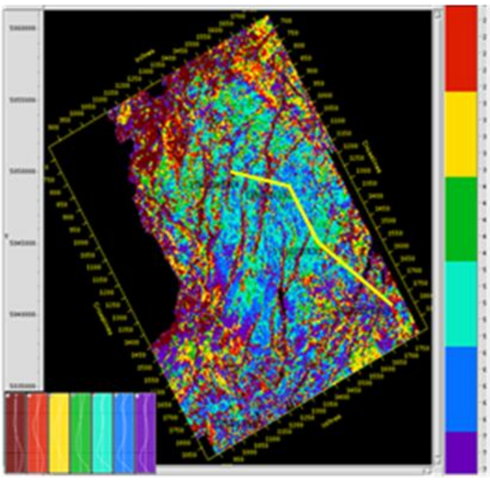

Fig3-1 waveform cluster in stage 3

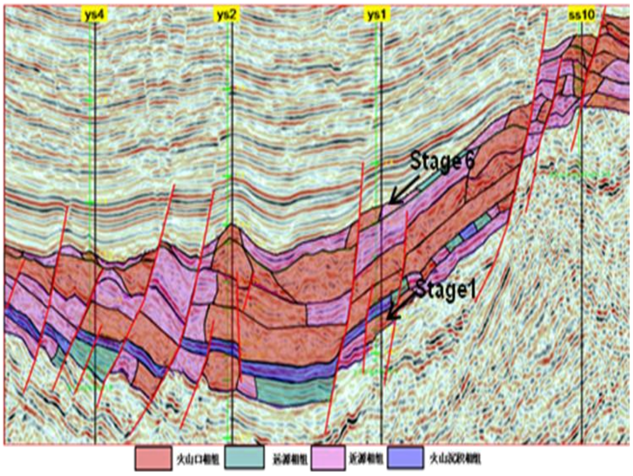

Fig3-2 volcanic facies division on seismic profile cross well ys4-ys2-ys1-ss10

4.2 Amplitude class attribute for the division of the volcanic rock facies in the study area boundary

Amplitude change attributes only relate with along the lateral changes of the amplitude of the layers window, and nothing to do with the absolute value of amplitude. By studying the change of the amplitude, identifying abnormal amplitude, depicting characteristics of sequence stratigraphy, identifying lithology change, and distinguishing the formation of continuous deposition, etc. Amplitude change attributes are without too much manual intervention, which extracted directly on the seismic data cube. Amplitude change attributes basically is the objective reality of geologic body, which avoid a series of result of manual calculation and operation compared with the inversion.

In the role of the RMS amplitude attribute, small values become smaller and bigger values are bigger, so data between the gap is widening, lateral changes of amplitude reflect more sensitive. RMS amplitude attribute can usually be used to identify the abnormal amplitude or used to describe the sequence stratigraphic characteristics. Root-mean-square amplitude attribute reflect the continuity of strata sedimentary by the amplitude changes, to distinguish the mounded deposits, deposit of unconformity, clutter deposits geologic abnormal body, etc. In the calculation method, The RMS amplitude squared and then do an average, so RMS amplitude attribute more sensitive to amplitude anomalies. On the specific operation, the length extracted by the right window is not only beneficial to the range of features of volcanic rocks, it is more conducive to the identification of the crater.

By comparing the drilling result with amplitude changes, root-mean-square amplitude attribute, it is discovered that there are three volcanic rock facies developed in the period of time, they are mainly crater facies group, proximal facies and far source group, respectively. The crater group-near the crater facies reservoir have large porosity, wide and long cracking, large pore throat radius, good pore throat sorting characteristics. Proximal facies group reservoir have middle porosity, small cracks, large pore throat radius, good pore throat sorting characteristics. They are all good reservoir. Volcanic rocks variation amplitude attributes figure in third stage, RMS amplitude attribute diagram in third stage shown in figure 3-3, 3-4.

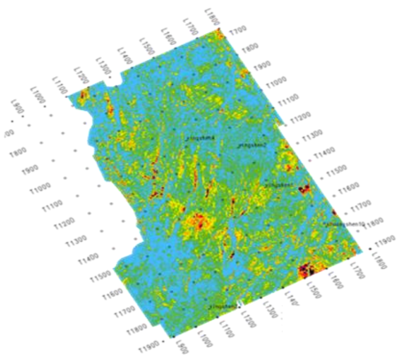

Fig3-3 Amplitude change attributes figure in stage 3

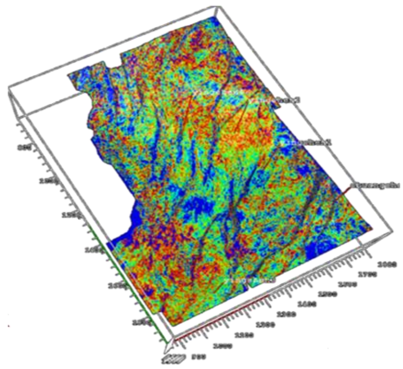

Fig3-4 Root mean square amplitude and structure diagram in stage 3

V. VOLCANIC FACIES DISTRIBUTION CHARACTERISTICS

Volcanic rock facies in the transverse follow crater - proximal facies groups - far source facies group - volcanic sedimentary facies pattern of development. Volcanic rock facies in the vertical direction follow proximal facies - volcanic sedimentary facies group - crater pattern of development. This shows that volcanic activities is from increase to decrease to enhance the process. Large increased volcanic sedimentary facies showed that volcanic activity has a tendency to die or stop, thus causing low limestone, shale and glutenite deposits, and increased far source facies group shows that volcanic activity weakened, but volcanic rocks are the main.

Use coherent detection to identify crater, trend surface analysis method to predict volcanic mechanism, and apply waveform clustering to distinguish the main boundary, then comply each period of the volcanic facies distribution. Comprehensive analysis found that the stage of 1, 3 (figure 4-1), 5 have strong volcanic activities, volcanic activity in the stage of 2, 4, 6 decreased, the main superiority of group (crater facies, near crater facies) distributed in the central and southern region in the study area; influenced by sedimentation greatly in the north and southwest, the main facies is far source facies and volcanic sedimentary facies groups.

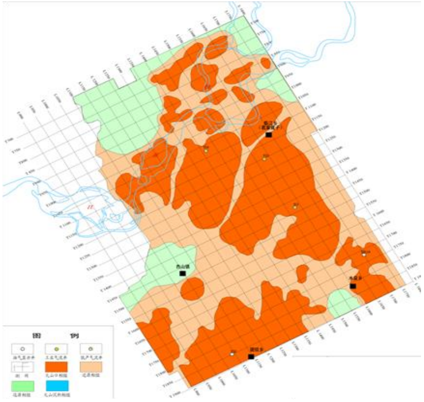

Fig4-1 the distribution of volcanic facies in stage 3

Compared facies results of well log and logging, result is consistent, this indicates that effect is good by using multiple attribute to predict volcanic facies in the study area. Crater facies and far source group have a relatively good porous condition, and they are suitable for storage and migration of the oil and gas reservoirs, and they guide the favorable area of hydrocarbon effectively.

VI. CONCLUSION

1) Use the coherent detection to identify crater, and apply waveform clustering to distinguish the main boundary, and finally apply multiple attributes and display means to refine boundary of volcanic rock facies zone, forecast favorable area is quite coincident with the actual situation.
2) Crater facies and far source group is less, they are located in the eastern volcanic belt and north side of the study area respectively. Near source facies group is main in a large area of the study.
3) Crater facies and far source group has a relative good porous condition, suitable for store and migrate of the oil and gas reservoirs, guide the favorable area of hydrocarbon effectively.

REFERENCES

[1] Dong Guodong, Zhang qin, Zhu Xiaomin, Current status and problems of volcanic reservoir study: an example from the Lower Permian volcanic rock in Ke-Xia area of Junggar Basin, *Oil Gas Geology, 33(4),* 2012, 511-519.

[2] Fisher R V, Schmincke H U, *P yroclastic rocks. (Heidelberg: Springer, 1984. 59-265).*

[3] Liu Xiang, Xiang Tianyuan, *Cenozoic volcanoes and pyroclastic deposits in Northeastern China resources and hazard*, (Changchun: Jilin University Press, *1997. 1-8).*

[4] Wang Pujun, Chi Yuan lin, Liu Wanzhu, Volcanic facies of the Songliao Basin: Classification, Charcteristics and reservoir significance, *Journal of Jilin University Earth Science Edition, 33(4),* 2003, 449-456.

[5] Chen Changle, Liu Yang, Liu Cai, Volcanic rock recognition by local seismic attribution, *Global Geology, 30(4),* 2011, 660-665.

[6] Zhou Tianqi, Ji Ling, Volcanic rock distribution prediction in Zao 35 block based on seismic attribute analysis technology, *Journal of Yangtze University 11(10)*, 70-73.