IOSR Journal of Engineering (IOSRJEN) **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719
Vol. 05, Issue 10 (October. 2015), ||V1|| PP 21-25

Application of seismic hydrocarbon detection technique to natural gas exploration-Take Yingshan rift volcanic in the Yingcheng Groups as an instance

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Abstract: **-** Based on the predictability of the seismic hydrocarbon detection technology on horizontal, it can be applied to predict the favorable zones. Known drilling shows that gas production of yingcheng group volcanic rocks on the yingshan rift is rich, on the basis of the pre-stack and post-stack seismic data, extract low frequency energy properties and AVO attributes (G), forecasting the containing gas province. Known drilling verification shows that the reservoir performance for weak interval clutter characteristics, stronger or weaker patchy distribution area in an abnormal gas bearing area, and the result is reliable, can be used in later exploration.

Keywords: **-** *Yingshan fault depression; seismic hydrocarbon detection technique; low frequency energy attributes; AVO attributes*

I. INTRODUCTION

In recent years, the volcanic rock gas reservoir is more and more attention, the hydrocarbon detection technology based on seismic information also has been widely used[1]. Seismic hydrocarbon detection technology generally includes AVO (amplitude changes with offset) analysis, based on the stratigraphic absorption coefficient and the testing technology of effective attenuation coefficient[2-5], this study based on the pre-stack and post-stack seismic data to predict gas distribution, forecasts the next exploration area.

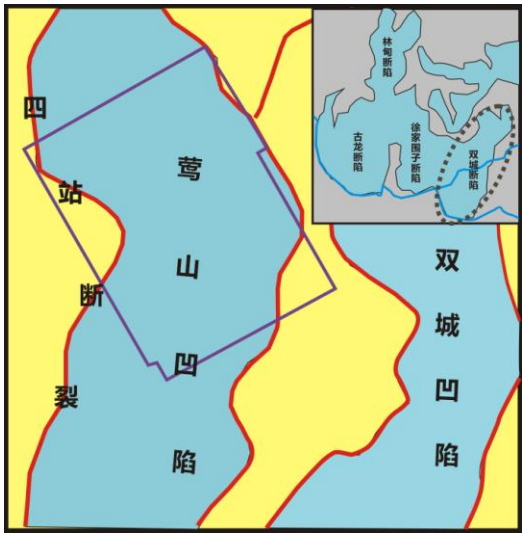

Figure 1 location map of the study area

II. REGIONAL GENERAL SITUATION

Yingshan Depression belongs to the deep structural unit of the southeast fault zone in the north of Songliao Basin, and is to the west of Xujiaweizi Fault depression, which is divided by the Chaoyanggou anticline belt. Yingshan depression is a asymmetric graben fault depressions controlled by sizhan fault and linjiang fault[6](figure 1). Yingcheng groups is at the fault depression period of the basin, and the glutenite and volcanic rock developed in yingsi section and yingyi section respectively. Known volcanic gas drillings show that Yingcheng groups have a lot of gas, including Well2 for industrial air well, Well1 and Well3 provide sustainable flow well. According to the characters of seismic reflection, the Yingyi section formation volcanic rocks can be divided into six periods, on the basis of seismic attribute extraction predict various natural gas distribution issue.

III. SEISMIC HYDROCARBON DETECTION TECHNOLOGY

2.1 volcanic reservoir hydrocarbon post-stack detection analysis

Theoretical studies have shown that compared with the density of the geological body, the local geologic body fluid such as water, oil or gas, will cause the seismic wave scattering and attenuation of seismic energy, namely relative strengthening of low frequency energy of seismic wave, high frequency attenuation level. Main gas or water in reservoir in this area, so the fluid attenuation in reservoir is mainly caused by rich in gas[7]. In theory, when pore in the reservoir is development and high in air pressure, the seismic wave attenuation of high frequency energy is bigger than the low frequency energy attenuation. Due to the viscous coefficient of gas is greater than the water's, so gas reservoirs attenuation is greater than water reservoirs. By extracting amplitude of energy between the layers seismic attributes and the change of attenuation of high frequency energy, we can have an indirect detection of hydrocarbon reservoir.

Work without drilling information in seismic gas detection, the result depends entirely on the quality of seismic data. And purpose layer buried deep in the study area, the poor quality of material, reduces the accuracy of anomaly detection. Through multiple attribute extraction and verification of drilling data, low frequency energy as post-stack hydrocarbon anomaly indicator sensitive attributes is the optimization. Consider volcanic rock formation of strong heterogeneity, study atmosphere in the low frequency energy performance for strong and weak interval clutter characteristics, stronger or weaker patchy distribution area in an abnormal gas bearing area.

2.2 Pre-stack hydrocarbon detection analysis of volcanic reservoirs

AVO reflect the amplitude information and offset, the relationship between the AVO attribute changes with offset and the relationship between lithology and hydrocarbon, according to the normal incidence in the top of the gas-bearing sandstone and reflection coefficient values, and gas-bearing sandstone is divided into four categories qualitatively, four types of gas-bearing sandstone AVO characteristic curves of each are not identical (8-9).

AVO forward modeling is phenomenon of forward modeling simulation, combine with the feature of reservoir in the study area, analysis of gas, water and the AVO characteristics of special lithologic body, build up AVO attribute test marks in this area. First of all, It must judge the reliability of seismic data and require well forward model of AVO response type clearly. Therefore researches of well2, well3 and well5 forward modeling, the forward analysis showed that the gas reservoir in this area show the evident I AVO anomaly (figure 2), and the higher gas bearing, AVO characteristics is the more obvious.

P profile in AVO attribute section is a true vertical incident P wave reflection coefficient of zero offset, composed of AVO intercept. G section reflects the comprehensive features of rock elastic parameters. Corresponding to the P wave peak, when slope G positive, said the amplitude increases with the increase of the offset; When slope G negative, said amplitude decreases with the increase of the offset. Corresponding to the P wave valley, when G positive, said the amplitude decreases with the increase of the offset; when slope G negative, said the amplitude increases with the increase of the amplitude with offset.

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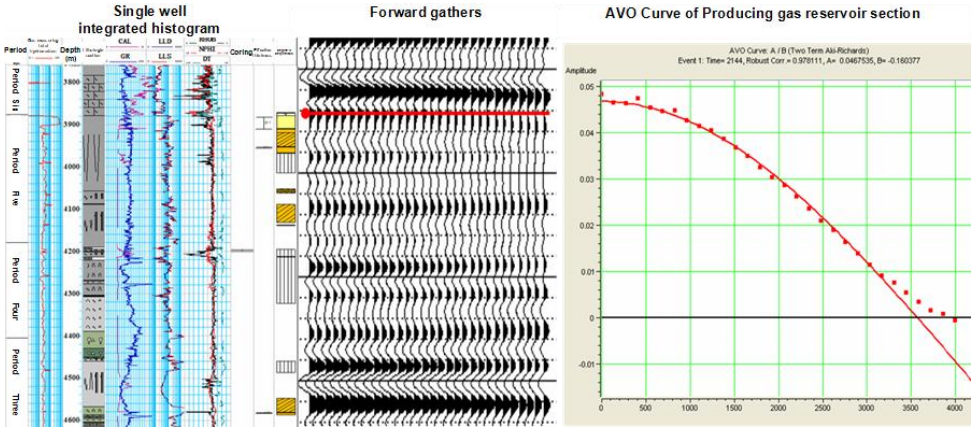

Figure 2 Well 2 forward gathers AVO characteristics analysis in Yingshan fault

IV. YINGSHAN FAULT DEPRESSION IN YINGCHENG GROUPS VOLCANIC ROCKS GAS DISTRIBUTION CHARACTERISTICS

3.1 Natural gas distribution characteristics

Using low frequency energy and AVO attribute to complete the study area of volcanic rock hydrocarbon detection, and compiled into figure. To complete the research area of each phase of the volcanic seismic hydrocarbon detection work. Characteristics of gas are strong and weak interval clutter, stronger or weaker patchy distribution area are in abnormal gas bearing area.

From the low frequency energy properties, high value area of issue 1 strong and weak interval clutter hydrocarbon is gas unusual, abnormal shows two bands. While exceptions exist near the western sizhan fault (F231), but due to the volcanic formation is very thin, anomaly was mainly affected by surrounding rock, no reaction of formation hydrocarbon showings. Issue 2 hydrocarbon abnormal characteristic is weak, scattered distribution, and has no obvious abnormal area, middle and low values in the embedded transition zone may gas bearing province, mainly in the southern of Well 3 and western of Well 2. Issue 3 hydrocarbon abnormal distribution range is larger, but overall abnormal characteristic value is lower, no obvious abnormal gas-bearing characteristics, compared with drilling analysis, mainly gas bearing province is low mixing zone, mainly distributed in Well 3, 2, 1 block, gas-bearing show the weak characteristics. Issue 4 hydrocarbon anomaly sporadic discrete distribution, mainly in Well 3, northern of Well 2, southern of Well 1, and a small scale of middle- high value anomaly instructions of hydrocarbons exist nearby sizhan fault. Issue 5 hydrocarbon anomaly characteristics indicate obviously, the characteristics are zonal distribution, it mainly concentrated in the middle of the distribution in the work area. Middle- high value areas are gas bearing areas, with northern and southern distribution, Well 1 and Well 2 are the axis of two abnormal stripes. Issue 6 hydrocarbon anomaly indicates show nearly north-south striped distribution, value of abnormal are big, middle-high value areas are abnormal gas bearing areas, they mainly distributed in both sides of the fault zone in central (figure 3).

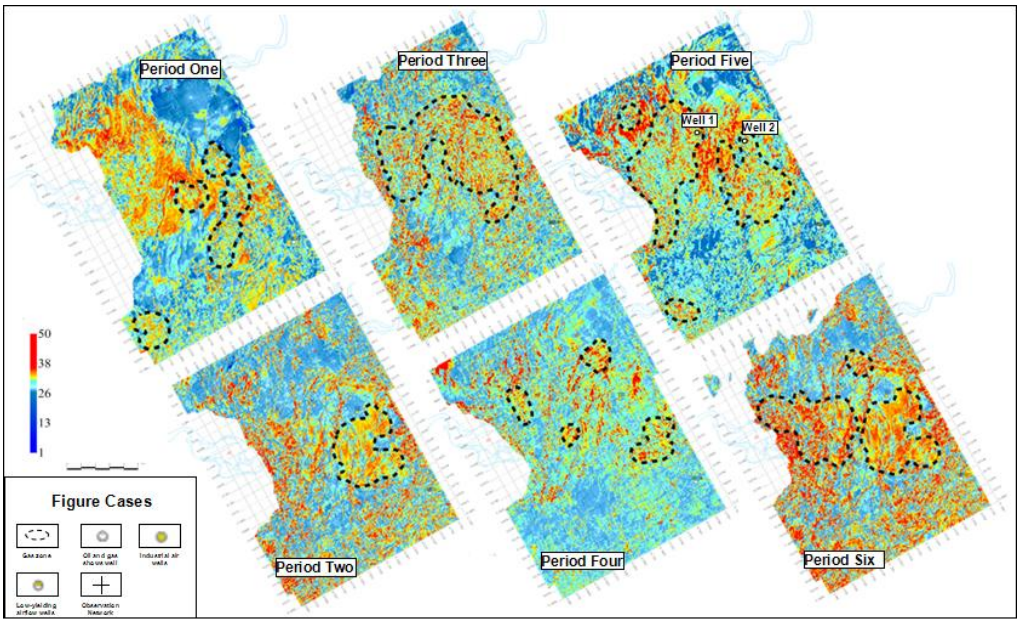

Figure 3 low frequency energy attributes map of Yingcheng groups volcanic rocks in Yingshan depression

From AVO attributes (G) figures, issue 1 anomaly has obvious concentration, and Well 3, Well 2 shaft alignment is higher, middle-high value areas are gas bearing areas. Issue 2 middle-high value clutter areas are gas bearing areas, mainly distributed near the Well 3 and Well 2, the west side of Well 3also has the small abnormal area, this issue is mainly composed of volcanic sedimentary rock, it didn't develop volcanic rock reservoir, so the whole hydrocarbon content is poorer, hydrocarbon gas didn't develop. Issue 3 middle-high value areas are gas bearing areas, distribution range is similar to low frequency energy. Issue 4 four scope ranges from middle- high value anomaly areas developed near Well 3, Well 2, Well 1 and the northern of Well5.Issue 5 overall performance is a middle-high value continuous abnormal area, overall the anomalous characteristics of gas has a hollow center. Issue 6 are characterized by two abnormal area, but distribution has obvious changes, the west strip anomaly characteristics and post-stack predicted results are basically identical, and the difference of eastern strip anomaly is bigger, the characteristic is migrating to the east (figure 4).

Overall, all issues pre-stack and post-stack properties differences are not big, but issue 4 hydrocarbon anomaly characteristics are weak, pre-stack and post-stack attributes have greater differences, comprehensive analysis are dense layer.

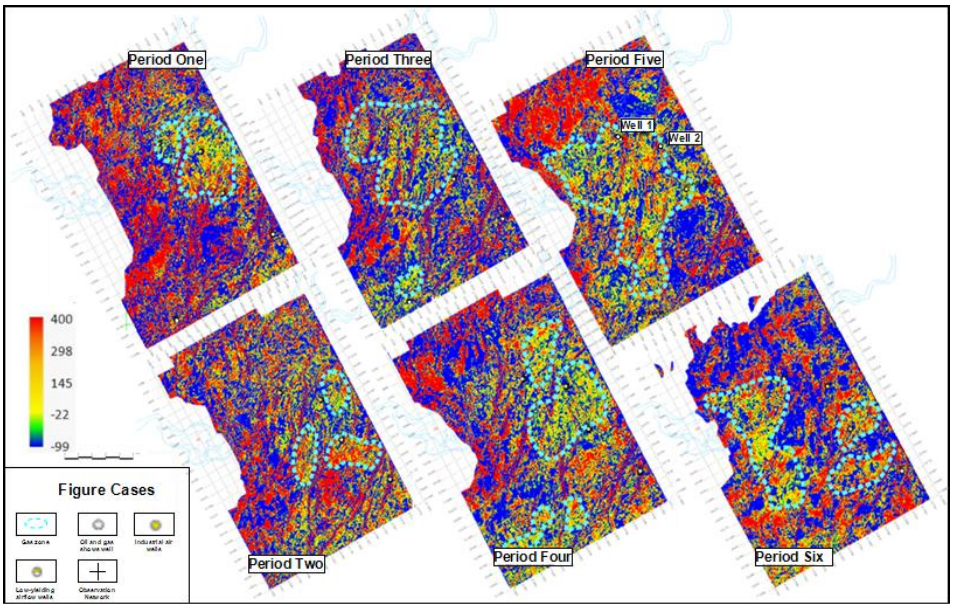

Figure 4 AVO attribute graph (G) map of Yingcheng groups volcanic rocks in Yingshan depression

3.2 Known drilling verification

Seismic hydrocarbon detection technology based on the seismic information, it shows the lateral prediction, and it is necessary to combine the single well data to verify its lateral predictability, it can make the results more reliable. Comprehensive logging interpretation and the test results indicate that Well1, Well2 are gas bearing in issue 5 (figure 5), both in the low frequency energy figures and AVO attribute figures are hydrocarbon anomalies, the result is reliable, it can be used to predict favorable area and to guide the next exploration.

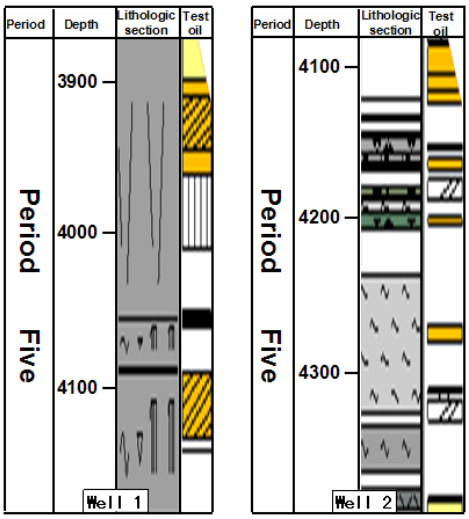

Figure 5 Well2 integrated histogram in Yingshan depression

V. CONCLUSION

Anomalies in the study area are I AVO anomaly, G attribute can effectively predict the volcanic eruption periods of hydrocarbon, gas reservoirs in the low frequency energy and AVO attributes are strength interval clutter characteristics, in issue 4 it is affected by dense layer, and in other issues the range of low frequency energy and AVO attribute prediction of containing gas province is similar; the known drilling verification shows that the hydrocarbon detection technology (low frequency energy and AVO attribute) are reliable, and can effectively predict the favorable zone.

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