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The meticulous depiction of volcanic rock from Es3z to Es3x in Hong Xing area in the eastern depression of Liao He Oilfield

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Abstract: Volcanic rocks in the eastern depression of Liaohe depression are widely distributed. Igneous rock reservoirs are so rich that they have great exploration potential of volcanic rocks [1]. Huang Shatuo oilfield has the proven reserves of nearly 40 million tons and its reservoirs are volcanic rocks only. Igneous rock reservoir has become one of the most important reservoir type of Liao He basin. However, igneous rock reservoir as a special type of reservoir, it has some specific characters such as the lithology changes fast, the oil-gas possibility is more complex and so on. In nearly adecade, the prospection of oil and gas in igneous rock has not made significant progress. This article established the eastern depression volcanic lithofacies identification through the shaft vibration and seismic reflection characteristics analysis; By the integrated application of waveform clustering, coherent, wave impedance inversion, time slice and any other technologies , this essay forecasted the volcanic plane distribution range; The favorable reservoir facies belts under different periods have been found, which achieved good exploration results.

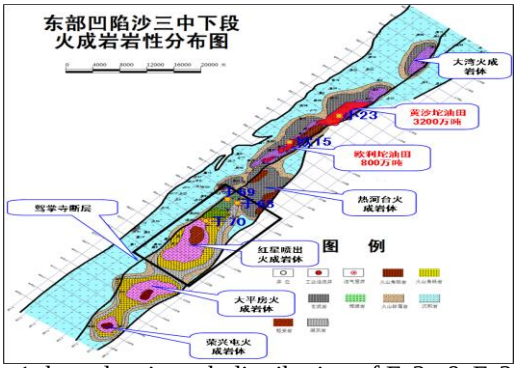
Keywords: *Volcanic rock reservoir; Crater; Lithofacies; Stratigraphic; sequence; Meticulous depiction of volcanic rock*

I. PREFACE

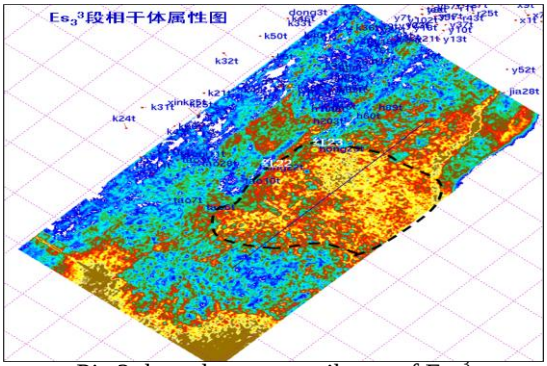
The study area is located in the eastern depression in Liao He depression. In the west it's near the central uplift. In the east Yingkou-Tong Erpu fault is its boundary [1]. In Jia Zhangsi depression, the largest sedimentary thickness is high to 4500-5000 meters what makes it the deepest center of subsidence in the east depression. Jia Zhangsi depression is also rich in volcanic rocks. Complex and great faults are common developed in the study area. Especially, the Tanlu fault crosses the study area. Fault activities and magmatic activities are always happening during the development of the depression. Volcanic rock was found in 518 wells of the finished prospecting wells and it mainly exists in Es3z and Es3x. Volcanic rock in this period is widely distributed and thick. The acreage is nearly 700 km2 and the thickest place is almost 2000 m.

II. THE RECOGNITION OF VOLCANIC ROCK AND THE DISTRIBUTION OF EXTRUSIVE ROCK

In terms of the present study, there are two mainly methods for identifying volcanic rock. One is seismic exploration means, the other is non-seismic exploration method [2]. Compared with sedimentary rock, volcanic rock has its own characters such as big density, more compact, high magnetic susceptibility and so on. By attributing extraction, we have found seven vulcanite body including Rong Xingtun vulcanite body, Da Pingfang vulcanite body, Hongxing vulcanite body, Re Hetai vulcanite body, Ou lituo vulcanite body, Huang Shatuo vulcanite body and Dawan vulcanite body [3](pic 1). So by seismic lithology modeling, seismic facies analysis, 3D visualization technology and other technologies, we can recognize volcanic rock [4](pic 2).



Pic 1 the volcanic rock distribution of Es3z & Es3x



Pic 2 the coherence attributes of Es_3

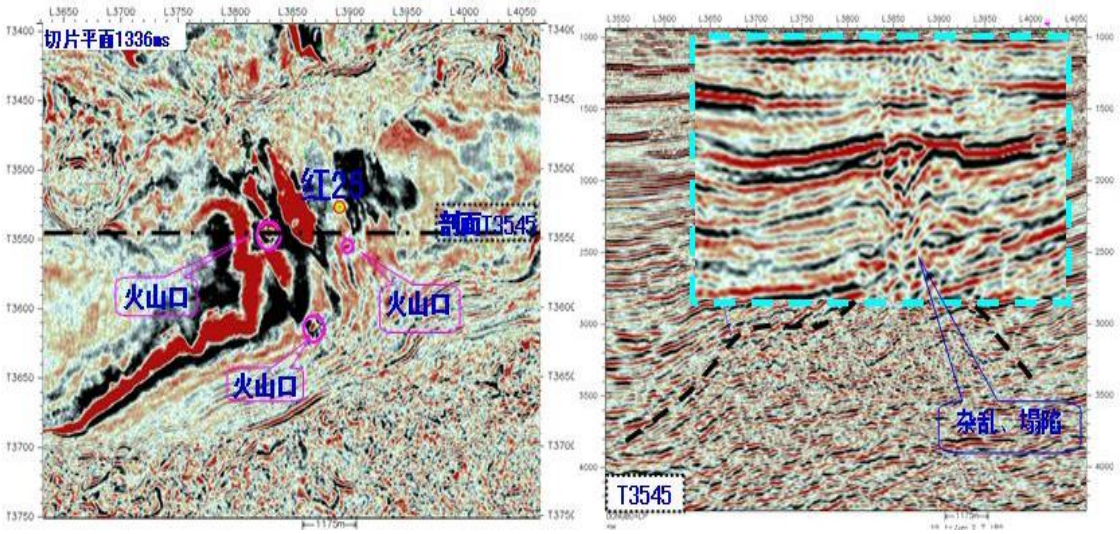
Of course, all of these technologies are depend on high-quality seismic data. However, in the area where geologic activities happen frequently, seismic data is usually of poor quality. With the development of non-seismic technology, it also plays a part in recognizing volcanic rock. The main methods include magnetotelluric method, the time domain field building method etc [4]. Because of the difference between volcanic rock and surrounding rock, we established the response characteristics of igneous rocks in the study area by the method of well seismic combination. From the data of a large number of prospecting wells and development wells, we found that overflow basalt was common [5].The volcanic rock of Es3z and Es3x can be divided into three large areas including Hongxing area, Yulou-Re Hetai rea and Ou LItuo –Huang Shatuo area. Lithological association is different among the three areas.

III. THE CHARACTERS OF VOLCANIC FACIES DISTRIBUTION

The analysis of volcanic facies is the basic of researching volcanic rock. Volcanic facies refers to the forming condition of volcanic rock and combination of the characters of lithology and lithofacies. Volcanic facies are divide into volcanic conduit facies, sedimentary volcanic facies, extrusive facies, overflow facies, volcanic eruption facies and explosive sedimentary phase [6].

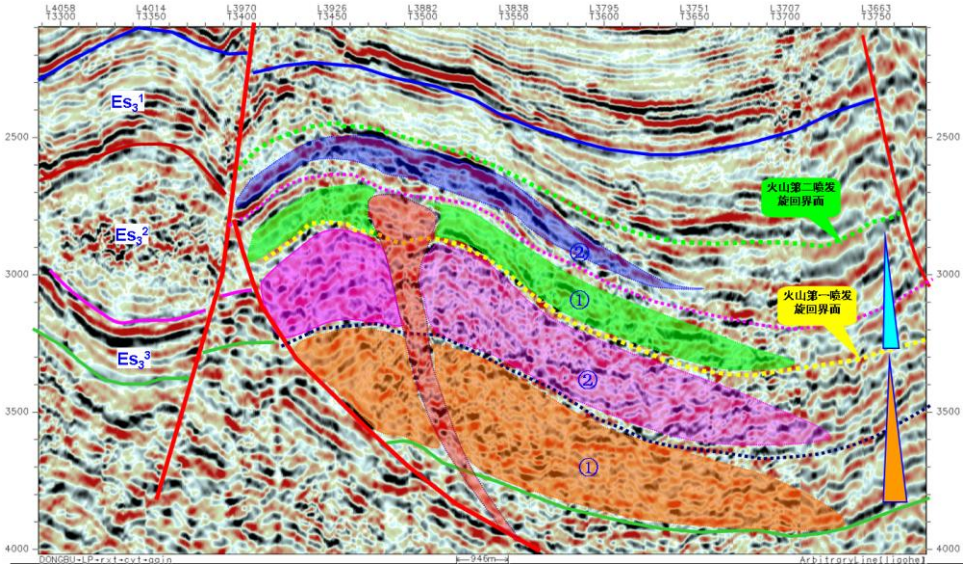
In recent researches, lithofacies have control on the pore formation of volcanic reservoir and oil&gas accumulation. The phase transition zone is the most favorable facies belt. The belt near craters is better, in contrary the boundary belt is worse. So, it's of vital important to recognize craters and different facies.

The crater is the direct channel and eruption center of magma, controlling the volcanic body and the distribution of volcanic facies. So, identifying craters is of vital important. The crater shows obvious subsidence characteristics in seismic sections, because of the seismic axis disorder caused by the volcanic eruption and differential compation. However, in the plane, the crater shows as "cycle-close" strong reflection. Influenced by volcanic activities , the seismic data is mussy, which makes it is difficult to recognize the early-stage crater position. In contrary, the terminal crater is easily ensured. Using these characters above, we can distinguish the early-stage crater. Taking use of time slice, to ensure horizontal distribution is essential. On the other hand, the crater shape on the time slice correspond to the subsidence in the seismic sections (pic 3).



Pic 3 time slice and seismic section character of crater

Hong Xing volcanic body eruption is controlled by the fault formed in Es3z and Es3x sedimentary periods. The main crater is in the east of the of the fault (pic 4).

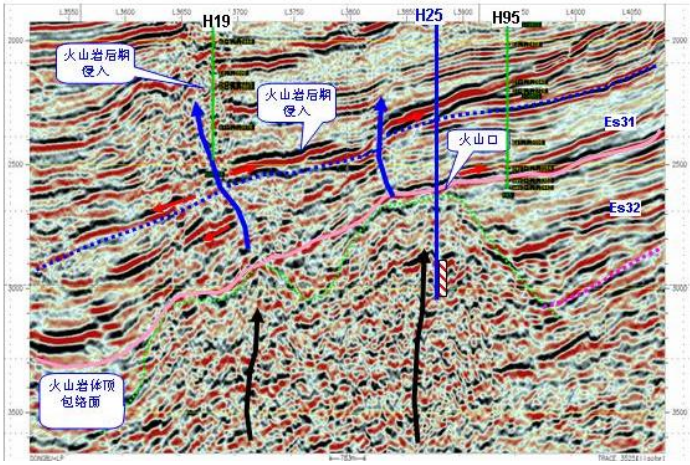


Pic 4 seismic section cross crater in Hong Xing area

IV. THE PRECISE DESCRIPTION OF VOLCANIC ROCKS IN HONG XING AREA

4.1Volcanic eruption pattern

In terms of the crater shape, there are three kinds of volcanic eruption patterns---Multiphase center eruption, Fissure eruption and Center—Fissure eruption. Hong Xing volcanic body belongs to the first type. The volcanic body erupted along Hong 25 crater and Hong 19 crater (pic 5).

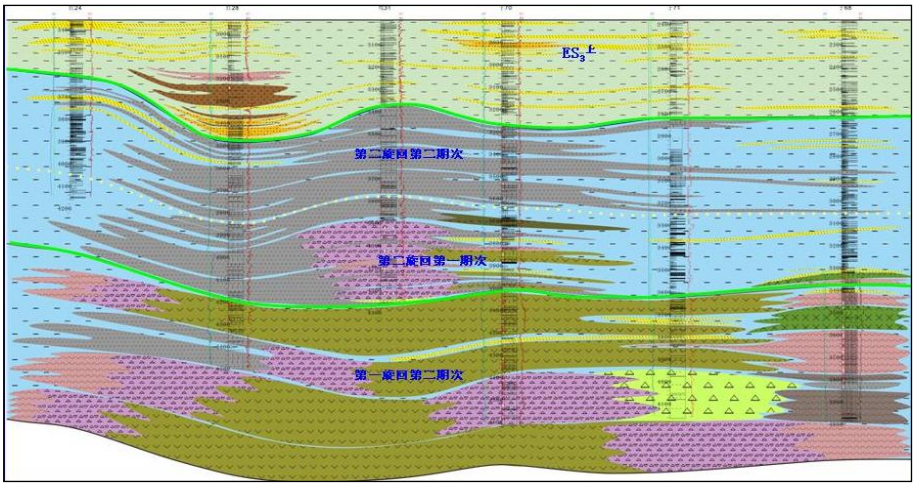


Pic 5 Hong Xing-Yu Lou volcanic body center eruption pattern

4.2 The cycle and period of the volcanic rock

On the basis of data from Hong Xing area, it is easy to find that volcanic rock thickness changes a lot vertically and the lithology is discontinuous. The lithology is different from different periods although at the same point. Different volcanic layer section is different in formation texting. So, we desperately need detailed study on large set of volcanic rocks.

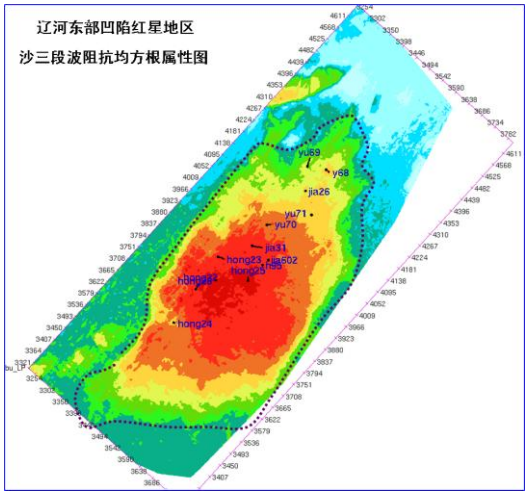
The power and lithology vary with the depth [7]. The deeper the eruption happened, the larger the power is. The lithology changes from acid rock to intermediate rock and basic rock [8].Usually, cycle refers to lithology variation vertically, which is just for sedimentary rock. However, we can combine the volcanic eruption cycle with seismic sequence. According to "cycle-period-lithology" theory, extrusive rocks of Es3 are divided into two cycles and four periods. On the basis of seismic facies characters, we set three class volcanic eruption pattern of Hong Xing area. The three class volcanic eruption pattern includes two cycles, four long periods and many short periods (pic 6).

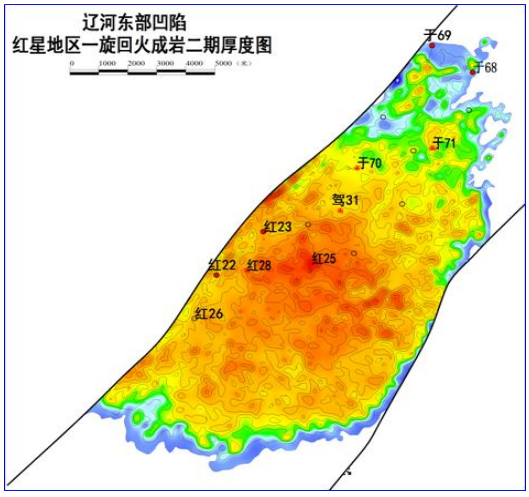


Pic 6 Recognization of cycles and periods in Hong Xing area

4.3 The precise description of extrusive volcanic rocks

The center of the eruption is just where the craters is [9]. By attribute description, the boundary of eruption can be confirmed. On the basis of "cycle-period" theory, the volcanic rock distribution is divided into two cycles and four periods. The first period of the first cycle distributes 130 km^2, and the largest depth is 900 m; The second period of the first cycle distributes 113 km^2 and the largest depth is 800 m; The first period of the second cycle distributes 59 km2 and the largest depth is 220 m; The second period of the second cycle distributes 69 km2 and the largest depth is 194 m. According to the data showed above, we confirm the distribution and the shape extending shape of different periods (pic 7 pic 8).



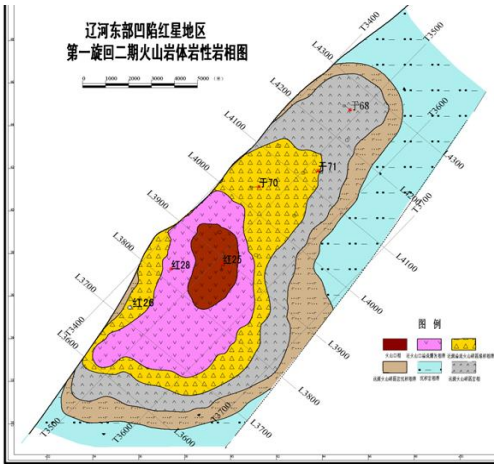


Pic 7 Wave impendance RMS of Es3z

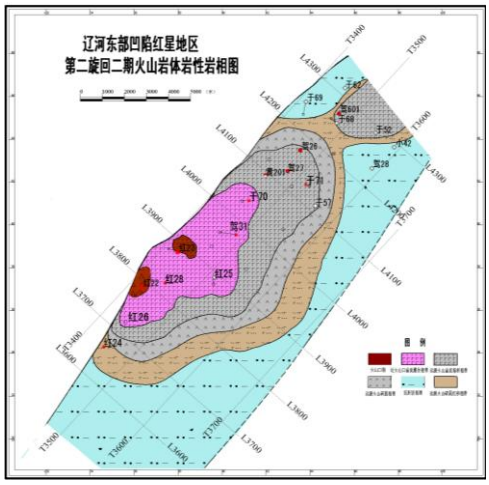
Pic 8 The depth distribution of I_2 volcanic rock

There are two kinds of volcanic rocks of Es3z and Es3x in the study area---Polycycle extrusive rock and layered intrusion.

Combining the well logging with seismic the whole volcanic body is divided into five facies---Crater facies, Near crater overflow facies, Far source volcanic overflow sedimentary facies, Far source volcaniclastic facies, Far source volcaniclastic sedimentary facies (pic 9 pic 10).



Pic 9 The distribution of I_2 volcanic lithology



Pic 10 The distribution of II_2 volcanic lithology

V. CONCLUSIONS

(1) Combing volcanic eruption cycle with seismic sequence, the Es3 of the study area is divided into two cycles and four periods.

(2) According to Crater recognition technology, Seismic facies analysis technology etc, the challenge of volcanic phase transformation fast is solved effectively.

(3)The partition of volcanic has been achieved and the favorable facies has been recognized.

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