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The fine sequence stratigraphic framework description in Zhaozhou Oilfield Zhou13 Block

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Abstract： - It is premise and basis for development work to establish accurate isochronous stratigraphic framework of high resolution according to the specific situation of the regional strata.It is an important condition for deepening single sand distribution to contrast on the transverse accurately.To the environment of river-delta facies,this paper takes Fuyu reservoir in Zhou13 Block for example to introduce method of stratigraphic division and correlation.Firstly, to start from determining marker bed and standard well,then to divide strata into small layers going aroud standard well and contrast outside step by step.In the end, we will finish setting up the unified stratigraphic framework of the whole block.

Keywords： - River-delta facies；Division and correlation；Marker bed；Standard well

I. INTRODUCTION

High-resolution sequence stratigraphy with inverse simulation of sedimentary processes as the main means to build high precision of Stratigraphic, clear reservoir heterogeneity and prediction of favorable reservoir cover is mainly used in non-marine deposits. Deng Hongwen, Wang hongliang etc.has given out that how to identify base-level cycle and study high-resolution sequence stratigraphy in fluvial facies reservoir.Zheng rongcai etc. has raised the six levels of continental basin base level cycle. After years of research, the concept and theory of high resolution sequence stratigraphy can be effectively applied in underground geological research and can provide effective analysis method and prediction tool for the fine stratigraphic correlation, sedimentary facies and reservoir characteristics,etc.

However,the Fuyu reservoir which is affected by lake-level fluctuation is river-dominated delta reservoir.These factors such as multi-source, strong heterogeneity have taken many problems of fine reservoir description to Fuyu reservoir.Therefore,it is necessary for Fuyu reservoir of Zhou13 Block in Zhaozhou Oilfield to have division and correlation appling high resolution sequence stratigraphy.

The main research content is as follows:

1、To make sure division principle of sedimentary unit；

2、To determine the standard well and work with cyclicity analysis;

3、To determine marker bed;

4、To contrast out from standard well step by step;

5、To establish wells' profile and finish unitive stratigraphic framework of study region.

II. THE REGIONAL SURVEY

Zhou13 block is near Zhaozhou Oilfield,south of Sanzhao Sag,east of Daqing placanticline.Fuyu reservoir whose buried depth is 1850m is in the third and the fourth members of Quantou Formation of lower

Cretaceous.This formation is composed of different thickness interbedding of aubergine,grey and celadon mudstone and sandstone. The structural evolution in Songliao Basin has been controlling sediment distribution in Quantou Formation and diagenetic evolution.The formation had been showing different settlementin Quantou Formation.With further central uplift and sedimentary characteristics of multicycle and multilevel,it reflects the ancient lakes' regular periodic activity.

III. THE DIVISION OF SEDIMENTARY UNIT

3.1 The division principle of sedimentary unit

The reservoir with the multiple sedimentary cycles in Daqing Oilfield is fluvial facies mainly,and the stability of the cycles becomes bad with the decrease of the cycle level.So we must control the depositional cycle from senior to low-level. That is to say we should use the method be called "cycle comparison and hierarchical control"[1]which is used to determine sandstone groups and small layers boundaries basing on similar horizon, curve and thickness.

3.2 Determination of standard well

The lithology of Zhou 801 Well is composed of a set of sage green cinnabar mudstone.The cored well give priority to normal cycle and has rare compound cycle.The natural gamma curve of Zhou 801 Well can reflect shale content, contact relationship and cycle character more accurately(Fig 1).

The formation of cored well-Zhou801 has the following characteristics:it grows completely,there is no fault, no obvious electrical characteristics and no clear stratigraphic cycles.So we choose Zhou801 Well to be the standard well.

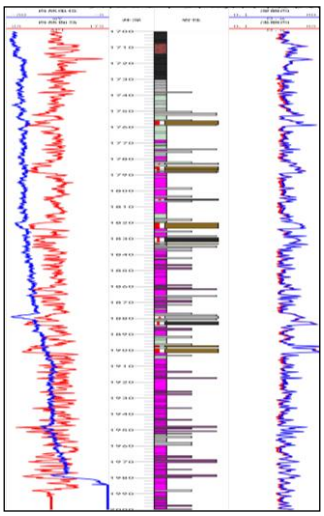

Fig.1： The comprehensive columnar section of Zhou801 Well

3.3 Cyclicity analysis of standard well

Through analyzing the standard well,The top and bottom planes of lakes invasion in Fuyu reservoir are caused by basin subsidence and lake level change.The cycle character which can be identified compared and traced more easily is more obvious[2-4].

We believe the Fuyu reservoir is lake regression-lake advance sedimentary,and FIII reservoir group is water regression-water advance cyclic sedimentation,FII reservoir group is water regression cyclic sedimentation,FI reservoir group is water advance cyclic sedimentation by appling sedimentology, sequence stratigraphy, logging geology and other methods(Fig 2).

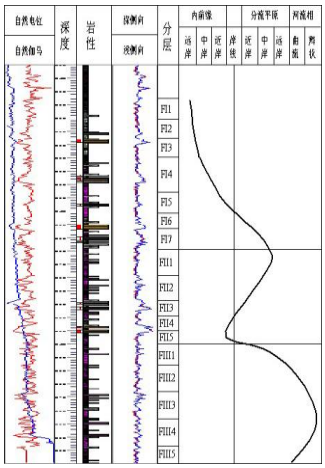

Fig.2： The cyclicity of standard well

3.4 Determination of marker bed

According to the sedimentary background,to form the dark half deep lake - deep lake facies mudstone in Qing I Member.Under the Qing I Member,there is a interbedding lithology combination which includes three groups of shale, marl and inferior shale and ostracod fossil is in layers of enrichment. The electrical characteristics is clear and stable. Three groups of high resistance layer is extremely obvious in microelectrode and three lateral depth curve. 0.25m, 0.45m, 2.5m and 4m apparent resistivity curves are obviously high resistance. Acoustic time which decreases down is very high.So we set this layer to be the top of standard layer[5](Fig 3).

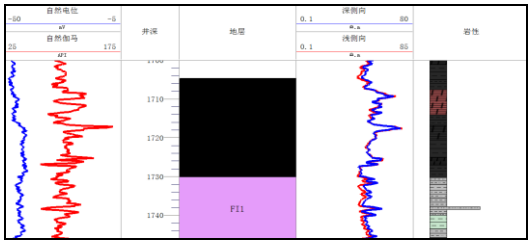

Fig.3： The electrical characteristics of standard layer of top of Fuyu reservoir

We can see the the color of the upper and lower sandstone between -1838m～-1845m is different.In this range sandstone is mainly grey and under the range it is mainly aubergine.According to the regular of sendimentary,it has appeared that much water flowing into this region.So we determin this step of mudstone as pre-emergency marked layer which is FⅠand FⅡ(Fig 4).

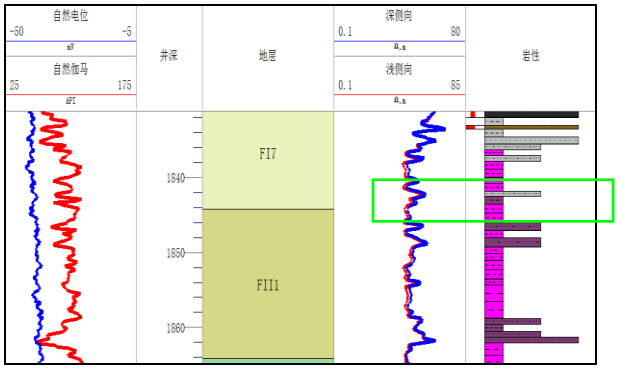

Fig.4： The Reservoir boundaries divided mark of Zhou801 Well FI and FII

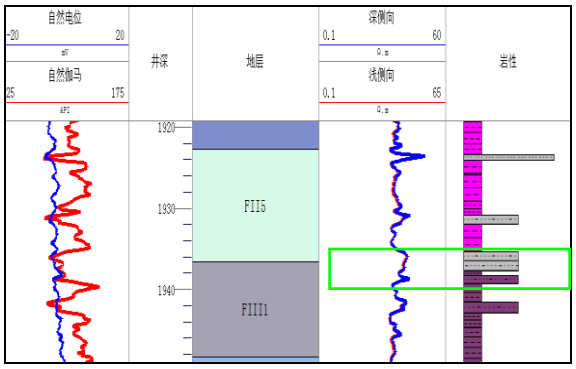

Fig.5： The Reservoir boundaries divided mark of Zhou801 Well FII and FIII

Therre is a set of mudstone which grows between -1915m and -1935m.On top of this set of sandstone, the color reflects the grey which is in weak redox environment and under this range it reflects the aubergine in the shallow water,which explains there was a water transgression event in the mudstone 's deposition process.So we determin this set of mudstone as pre-emergency marked layer which is FⅡand FIII(Fig 5).

3.5 Determination of cored well small layers

To determine FⅠ、FⅡ、FⅢreservoir group according to the marker bed and pre-emergency marked layers and divide small layers of reservoir groups according to short period cycle.Finally,we put the Zhou801 Well of Fuyu reservoir into three reservoir groups(FⅠ、FⅡ、FⅢ),seventeen small layers（FⅠ1-7、FⅡ1-5、FⅢ1-5）. Small layers characteristics is as follows(Fig 6):

（1）FⅠ1 subzone

The FⅠ1 subzone gives priority to deltaic front deposit and develops underwater distributary channel sand and sheet sand.The delta front was affected by lakes in some ways and the energy of underwater distributary channel falled away under the influence of lakes.

（2）FⅠ2 subzone

The FⅠ2 subzone which lithology is mainly silty sand,silty mudstone and mudstone belongs to deltaic front deposit and develops underwater distributary channel and sheet sand.The FⅠ2 subzone can be divided into twe positive rhythms which is crude under it and slimsy above it.

（3）FⅠ3 subzone

The FⅠ3 subzone which lithology is mainly silty sand,muddy siltstone, silty mudstone and mudstone belongs to delta plain and develops sdistributary channel sandbody and thin sand between the fluid.The FⅠ3 subzone is usually positive rhythm deposit which is crude under it and slimsy above it.

（4）FⅠ4 subzone

The FⅠ4 subzone which lithology is mainly silty sand,muddy siltstone, silty mudstone and mudstone belongs to delta plain and develops sdistributary channel sandbody,thin sand between the fluid and mudstone. The FⅠ3 subzone usually develops into two positive rhythms in the depositing process.The formation thickness becomes thinning gradually from northwest to southeast and the cyclicity is positive rhythm which is crude under it and slimsy above it.

（5）FⅠ5 subzone

The FⅠ5 subzone is mainly aubergine mudstone,sage green mudstone and light grey mudstone.The FⅠ5 subzone is positive rhythm deposit which is crude under it and slimsy above it.

（6）FⅠ6 subzone

The FⅠ6 subzone belongs to meandering river deposit and develops point bar,natural barrie,splay,floodplain and so on.The channel sand body shows zebraic distribution on the plane and lensing distribution in the profile.The logging curve shows bell-shaped curving or bell-shaped with tooth curving. The FⅠ6 subzone is positive rhythm deposit which is crude under it and slimsy above it.

（7）FⅠ7 subzone

The FⅠ7 subzone which lithology is mainly siltstone argillaceous siltstone, silty mudstone, aubergine mudstone and sage green mudstone belongs to meandering river deposit and develops point bar,natural barrie,splay,floodplain and so on.The dual laterolog curve shows high range.The logging curve shows bell-shaped curving or bell-shaped with tooth curving,some times we can see mat-like curving or mat-like curving with tooth.It is mutant contact in the bottom of FⅠ7 subzone and gradient type contact on the top of FⅠ7 subzone. The positive cycle of FⅠ7 subzone is obvious.

（8）FⅡ1 subzone

The FⅡ1 subzone which lithology is mainly gray siltstone，grey purple siltstone，argillaceous siltstone,silty mudstone, aubergine mudstone and sage green mudstone belongs to meandering river deposit and develops point bar,natural barrie,splay,floodplain and so on.The logging curve shows bell-shaped curving or bell-shaped with tooth curving,some times we can see mat-like curving or mat-like curving with tooth.The top of FⅡ1 subzone has a small reverse cycle.

（9）FⅡ2 subzone

The FⅡ2 subzone which lithology is mainly gray siltstone，grey purple siltstone，argillaceous siltstone,silty mudstone, aubergine mudstone and sage green mudstone belongs to meandering river deposit and develops point bar,splay and mudstone. The logging curve shows bell-shaped curving or bell-shaped with tooth curving,some times we can see mat-like curving or mat-like curving with tooth.Usually,The FⅡ2 subzone gives priority to two positive cycles and some have one positive cycle.

(10)FⅡ3 subzone

The FⅡ3 subzone which lithology is mainly lightgrey argillaceous siltstone,grey argillaceous siltstone,aubergine mudstone and sage green mudstone belongs to meandering river deposit and mainly develops natural barrier and mudstone.The logging curve is secondary or lower amplitude.The positive cycle is obvious.

(11)FⅡ4 subzone

The FⅡ4 subzone which lithology is mainly lightgrey gray brown siltstone,littlegrey siltstone, littlegrey muddy siltstone,aubergine mudstone and sage green mudstone belongs to meandering river deposit and mainly develops natural barrier and floodplain.One type of logging curve is high amplitude dual laterolog curve and the logging curve shows bell-shaped curving or bell-shaped with tooth curving,some times we can see mat-like curving or mat-like curving with tooth.The other type of logging curve is low amplitude but mplitude difference is small.The curve shape is low and horizontal.The positive cycle is obvious.

(12) FⅡ5 subzone

The FⅡ5 subzone which lithology is mainly lightgrey gray brown siltstone,littlegrey siltstone, littlegrey muddy siltstone,aubergine mudstone and sage green mudstone belongs to meandering river deposit and mainly develops natural barrier and floodplain.One type of logging curve is high amplitude dual laterolog curve and the logging curve shows bell-shaped curving or bell-shaped with tooth curving,some times we can see mat-like curving or mat-like curving with tooth.The other type of logging curve is low amplitude but mplitude difference is small.The curve shape is low and horizontal.The positive cycle is obvious[6-9].

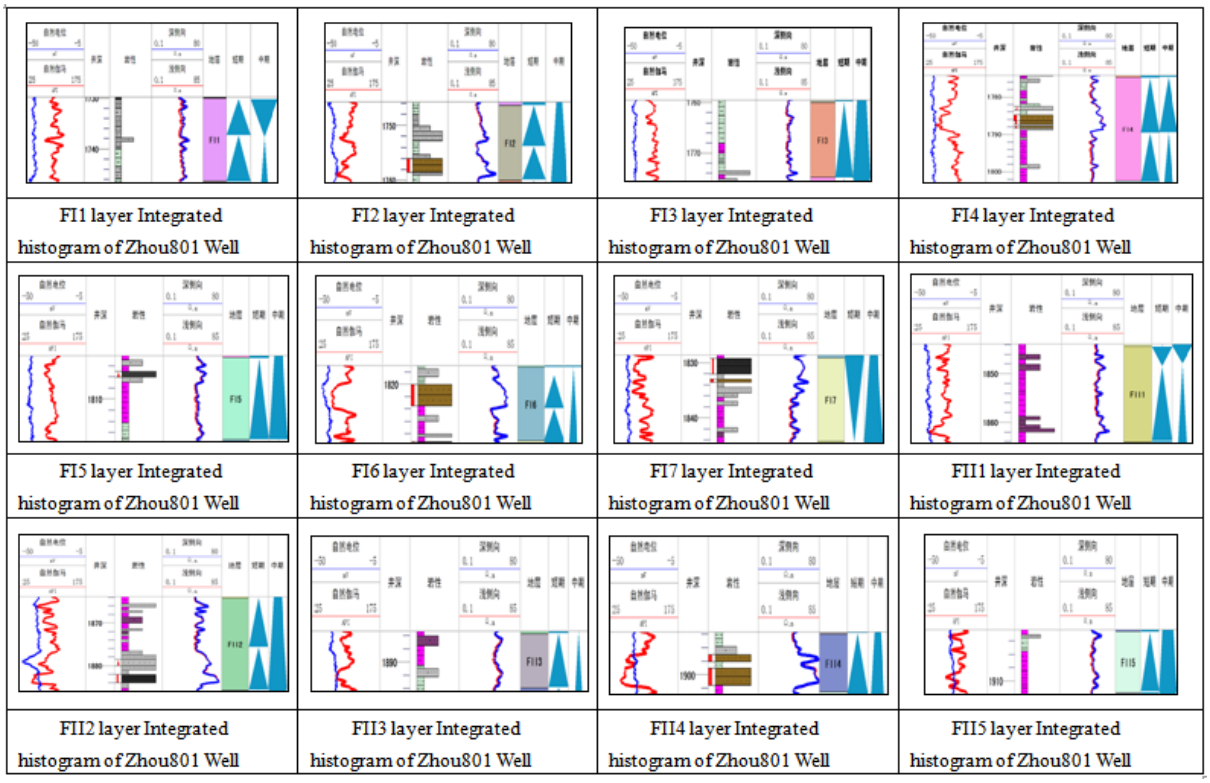

Fig.6： The small layers' integrated histograms of Zhou801 Well

In the end we finish determining the stratigraphic framework of Zhou801 Well(Fig 7) through analyzing the standard well.

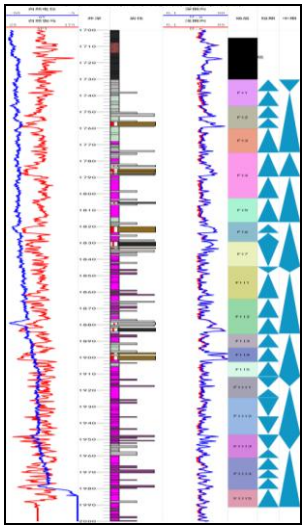

Fig.7： Stratigraphic framework of Fuyu reservoir

IV. COMPARISON OF SMALL LAYERS

4.1 To establish the standard profile and skeleton network

To establish wells' stratigraphic relations starting with the direction of changing little in lithology outside the Zhou801 Well.Then to establish skeleton section going around profile to control the whole region.According to the large area characteristics in study area,we establish skeleton network with 4 being vertical to direction of source and 3 along the direction of source,and draw contrast section of small layers(Fig 8)

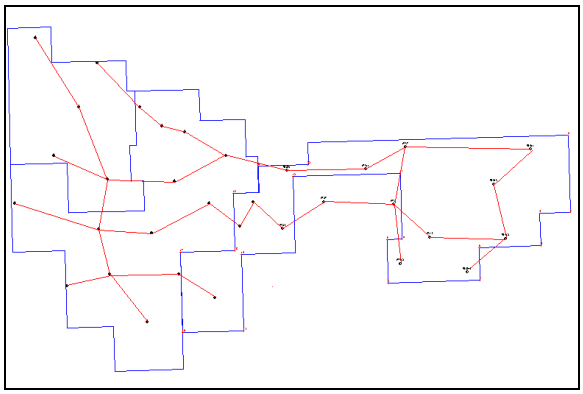

Fig.8：The skeleton network in in Zhaozhou Oilfield Zhou13 Block

4.2 Division of uncored well subzones

Firstly,to recognize the standard layer of top of Fuyu reservoir.Then to determine uncored well pre-emergency marked layers according to Zhou801 Well's.After the two steps,we can determine FⅠ、FⅡand FⅢreservoir groups.Finally,to divide uncored well according to wells' cyclicity reflected by logging curves(Fig 9).

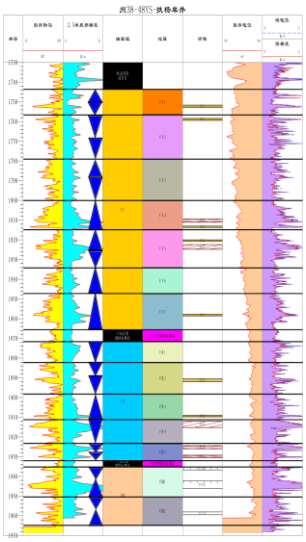

Fig.9：Division and correlation of coring well

4.2 Comparison of multiple wells to determine the small layer of the non coring wells

Top of FI formation has unconformity with the overlying Qing I Membe oil shale, and conformity with underlying strata, The overall distribution of the whole region is thick and the lithology is mainly composed of silty sand, silty mud， mud. Cyclicity of small layer mostly shows positive rhythm with crude lower fine upper.

FII formation has conformity with underlying FIII formation, the lithology is mainly contains grey and grey purple silty sand, muddy silt, silty mud, purple red and gray green mud. The curve pattern is mainly bell-shaped or gear bell-shaped, few of them are box-shaped or gear box-shaped, is composed of five short-term cycles. On the whole, the incomplete symmetric short-term base cycle is the main asymmetric short-term base cycle.

FIII formation in part of the study area is missing, but has little change in overall thickness, most are 65~85 meters. It is composed of five short-term cycles, mainly performs incomplete symmetry short-term base cycle which has mostly acending half cycles (Fig 10).

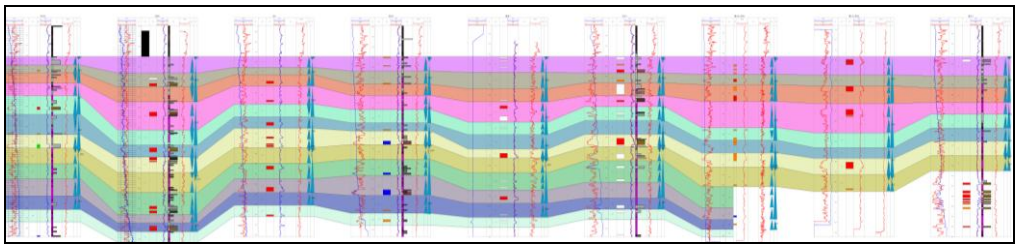

Fig.10：Wells' profile from east to west

V. CONCLUSION

1、Through the analysis of the standard well cyclicity, Fuyu reservoir is composed of a set of triple cycle and the cyclicity is positive rhythm which is crude under it and slimsy above it. FI reservoir group is coposed of 7 short-term cycles, FII reservoir group is coposed of 5 short-term cycles, FIII reservoir group is coposed of 5 short-term cycles.

2、To determine stratigraphic framework of Fuyu reservoir by combining high-resolution sequence stratigraphy, sedimentology,logging geology study and so on.They are three reservoir groups—FⅠ、FⅡ、FⅢ,seventeen subzones—FⅠ1-7、FⅡ1-5、FⅢ1-5.

3、This study unifies the region's standard of division and correlation and clear the correlation relationship of small layers.At the same time it explains division and correlation method of river-delta facies formation in detail. This is an important reference for the surrounding oil division and correlation and has an important practical significance for rolling exploration and development of oil field in the future.

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