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Method of precisely extracting sandwich angle in point bar ——three point method

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Abstract： - In fluvial strata, point bar sand body oiliness best, multiple lateral accretion internal distributes. In the late stage of oilfield development, the residual oil is mainly distributed in the point bar sand body. Interlayer distribution in point bar is an important factor that affects the residual oil distribution, clear interlayer spatial distribution characteristics, is the focus of current research. Dissection inclination can be read directly from the core data,when lack of core data, through a variety of methods to calculate the angle, including wide-depth method, convex abandon surface method, subwells method, etc. After reliable verification, three point method is the most accurate.

Keywords： - Point bar；Architectural structure；Three point method；Lateral accretion

I. INTRODUCTION

With the deepening of oil field development, many oil fields in China has entered a period of high water cut, especially the changyuan area of Daqing Oilfield, has entered the stage of high water cut stage in development, remaining reserves scattered in space, potential difficulties. Now, facing 40 million tonnes of production stabilization task, how to tap the remaining oil has become the major problem of enhanced oil recovery. Among remaining oil reservoires, meandering point bar sandbodies accounted for a large proportion, dam seepage flow characteristic and modeling, formation and distribution of residual oil in mechanisms, such as the choice of the means of tapping a range of issues, today become large issue for development geologist.

Internal architecture of single sand body plays an important role in controlling reservoir heterogeneity, residual oil affected by lateral accretion mezzanine space structure , integrated internal changes in the permeability of space in lateral accretion body and level 4 interface flows, etc, and mainly located in the upper part of the reservoir. Currently means is using deposition principle and levels analysis theory, on sand body internal structures for fine research; through side product interface controlling, established three dimensional geological model, that can describe side product sandwich resistance flow and heterogeneity changes in lateral accretion body.Generally react points dam internal three dimensional heterogeneity changes actually, provide enough geological accordings for flow points dam storage layer tapping. Based on meandering point bar sandbodies lateral accretion within the thin layer of clear inclination of lateral accretion of sandwich size, only a clear angle of sandwich, can only be determined in the future research mezzanine flat, profiles, point bar so as to adopt effective ways of remaining oil in mining.

II. REGIONAL GEOLOGICAL CONDITIONS

The study area, west of north-three-east block of Saertu oil group is northern river-delta sedimentary system with fluvial facies and delta facies,which is far source, gentle slope and long cuttent. The study area north begins with B3-D4-50 and B3-D4-P57 connection, south to B2-3-59 and B2-3-68 connection, west begins with B3-D4-50 and B3-5-59 connection, east to B3-D4-P57 and B2-3-68 connection, 5.4km2 area. The important sedimentary unit SII13+14b has delta distributary plain subfacies, microfacies types are: main channel, class Ⅰchannel, class Ⅱchannel, class Ⅲchannel, abandoned channel, crevasse channel, main overbank

sand , overbank sand, muddy siltstone, silty mudstone, interdistributary mud. Area of river sedimentary is developed, sand body is relatively small, the overall to four small distributary channels and fourteen notably small distributary channels.

III. STUDY METHOD ON BUILDING STRUCTURES

Analysis of reservoir architectural elements by the A. D. Miall [1] was first proposed in 1985, many scholars in China and abroad do further research following, basicaully form the [2-9] study method of meandering river facies reservoir architecture and remaining oil. For the extraction of single lateral thin mudstone interbed architecture parameters, the existing research methods including the core structure and determine the interface angle, subwells interface structure determine the angle, interface structure determination of abandoned dip, microfacies extraction of 4 level structure body scale, dense well group extraction of level 4 anatomical structure scale, the physical parameter calculation level 4 interface dip method. When facing the lack of core, logging data conditions, interface angle can not directly read, often through calculation, get the approximate value of angle.

The SII13+14b unit develops five abandoned channels, the point bar sand body surrounded by an abandoned river in southern area is the most typical point bar reservoirs in the unit,it is also the focus of this study. From this point dam as an example, introduces the step of using three point method to quantitatively calculate the interface structure angle, then compares with interface dip striking with other methods, in order to prove three point method is the most accurate, most close to the true value of the research methods under the circumstances of lack ing of core cases.

I. DETERMINE THE INTERFACE ANGLE WITH THREE POINT METHOD

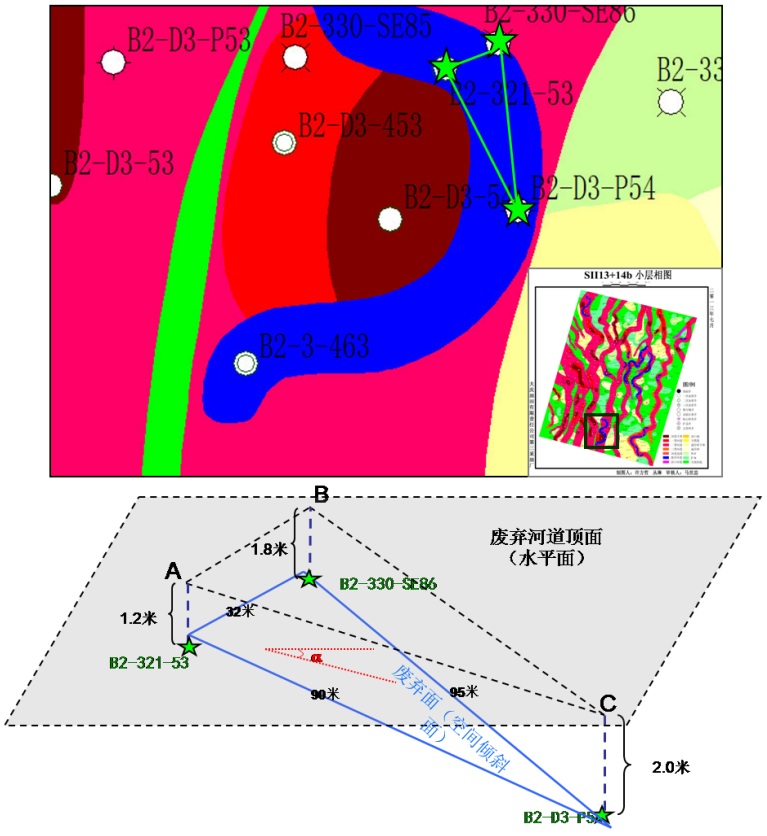

Fig.1： Diagrammatic sketch of calculating the angle with three point method

When drilling three or more close wells in the same abandoned channel, using the 3 point fixed surface principle to determine the angle of lateral accretion. Three point method for interface dip calculation method is based on the three-dimensional geometry, the predecessors have put forward the method, detailed calculation process will be particularly described in this study.

The object of study in small meander channel of SII13+14a unit, abandoned channel is located in B2-330-SE86, B2-321-53, B2-D3-P54, wells B2-3-463, point bar surrounded by abandoned river, located in B2-330-SE85, B2-D3-453, B2-D3-54 wells.

B2-330-SE86, B2-321-53, B2-D3-P54,these three wells located adjacent to each other, in a ring in the abandoned channel, then 3 point set surface principle to determine the lateral direction is available (Fig 1).

B2-321-53 and B2-330-SE86 has 32 meters apart, B2-330-SE86 and B2-D3-P54 has 95 meters apart, B2-321-53 and B2-D3-P54 has 90 meters apart.

Abandoned surface of well B2-321-53 has 1.2 meters gap in high from top surface, abandoned surface of well B2-330-SE86 has 1.8 meters gap in high from top surface, abandoned surface of well B2-D3-P54 has 2 meters gap in high from top surface.

As the figure: abandoned surface and the top surface intersect in MN, three wells distance is known, according to the similar triangle relationship, ON is 225 meters long, OM is 950 meters long, MN is 742 meters long.

According to the cosine theorem, the MNO angle is 154.48 degree, the NMO angle is 5.84 degree, the NOM angle is 19.68 degree, make OP from the point of O perpendicular to MN on point P. Because OC is perpendicular to the top surface, according to the projective theorem ,PC is perpendicular to the MN.

In the triangle MPO, three angles is known, length of MO is known, OP can be obtained 96.66 meters long.Then sinα=2/96.66, the angle is 1.19 degree.

According to the spatial geometric relationship, obtain the abandoned surface inclination is 1.19 degree.

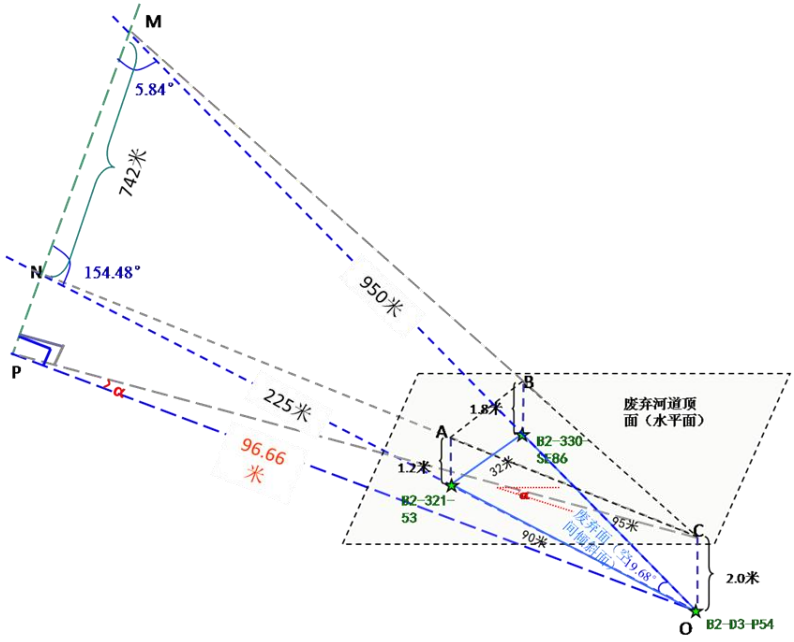

Fig.2： Three point method calculation

Because the abandon surface is concave on the waste is usually slow in steep slow down, easy to cause the inclination for error, often take half the distance, which is half of figure CP, the dip angle is 2.37 degrees (Fig 2).

IV. OTHER METHODS OF STRIKING DIP SANDWICH

After using the three point method to calculate the interlayer inclination, to the same point in the dam interbed dip to calculate by other different methods, compare the results of different methods.

4.1、Wide-depth method to strike angle

To the same abandoned river in study area, using wide- depth method again for dip. After measurement, full width of the abandoned channel is 36.4 meters, the average thickness of the point bar sand body is 2.4 meters, according to the Schumm relation to calculate maximum width WL in plane of lateral accretion body:

$$W_L = 2W/3 = 2\times 36.4/3 = 24.3m \text{(W is the full width)}$$

Then the lateral accretion angle for:

$$\tan\alpha = h/W_L = 2.4/24.3 \text{(H is the thickness of sand body)}$$

$$\alpha = 5.64°$$

4.2、Determine tendency and inclination with the abandon surface of convex bank method

Because of the results of the above two methods for obtaining the point bar interface dip is very different, using third methods - determination the dip by using abandon surface of convex bank method, to calculate the angle of lateral accretion surface in this point dam(Fig 3).

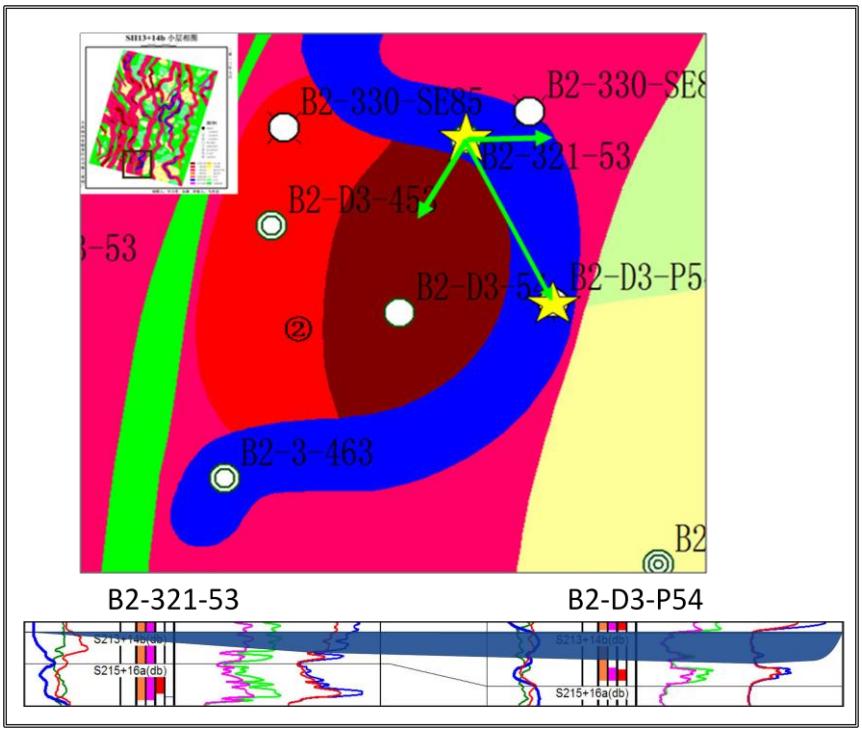

Fig.3： Diagrammatic sketch of determine the inclination with the abandon surface of convex bank method

B2-321-53 and B2-D3-P54 locates 91m apart, north-south distribution, abandoned surface has gap in height for 0.8m, tan (α) =0.8/91 ,the result is:

$$\alpha \approx 0.50°$$

If distribution is south-west, inconsistent with a planar phase distribution, as the intersection angle between apparent dip and the true dip is 64 degree, the calculated true dip angle is really:

$$\beta \approx 1.15°$$

4.3、Subwells determine dissection tendency and inclination

Subwells generally refers to the adjacent wells that distance between them is less than 50m, when 2 subwells have encountered the same abandoned, and the well profile perpendicular or nearly perpendicular to

abandoned channel, especially at the beach, we can determine the lateral surface (lateral accretion top) angle. In point bar,B2-D3-453 locate away from B2-D3-54 for 71m, belongs to the close sub wells under dense well pattern condition in the study area, connecting well section nearly vertical to the abandoned channel, abandoned surface height gap is 2.1m (Fig 4),

$$\tan(\alpha)=2.1/71$$

The calculation result is

$$\alpha\approx 1.65°$$

Much less than the theoretical value, half the spacing should be used as abandoned channel boundary ,then two wells locate away from 35.5m, the calculated angle

$$\alpha\approx 2.30°$$

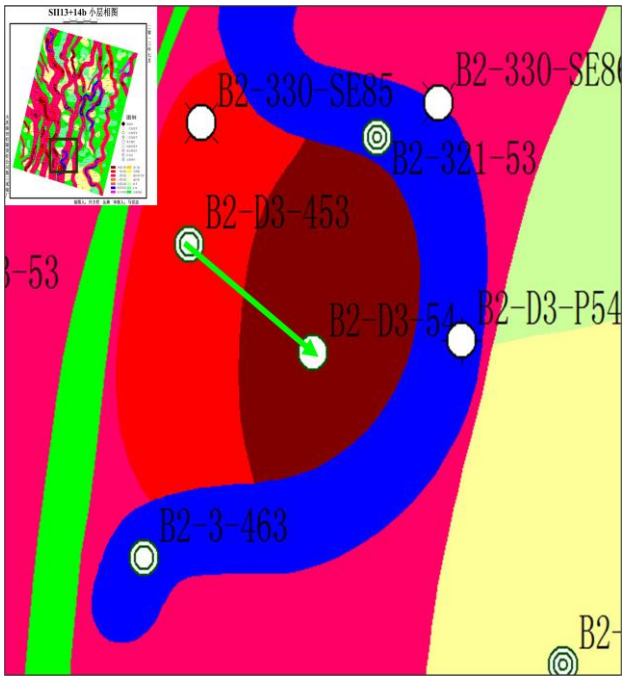

Fig.4： Diagrammatic sketch of subwells determine dissection tendency and inclination

V. TO DETERMINE THE ANGLE OF SANDWICH WITH CORE DATA

Mainly extract the level 4 lateral accretion interface dip at the point of well,when the construction is nearly horizontal or the horizontal bedding surfacethe of dark mudstonethe is perpendicular to core cylindrical surface, interface dip can be directly measured in the core, otherwise,we need to construct dip correction.

There is a coring well B2-D3-453 in B2-330-SE85, B2-D3-453, B2-D3-54 point bar, causes of meandering river sand body core is top unit flooding,horizontal bedding mudstone calibrate tendency during sedimentary period.The angle between the medial layer of point bar and the flood plain mudstone layer is equcal to lateral accretion layer angle (Fig 5). The SII13+14b unit sand body identified in the core,the interlayer shown on logging curves can correspond to gray white mudstone interlayer in the core, sandwich angle of the top surface in the core is measured 3 degree, the angle of the bottom surface is 2.6 degree.

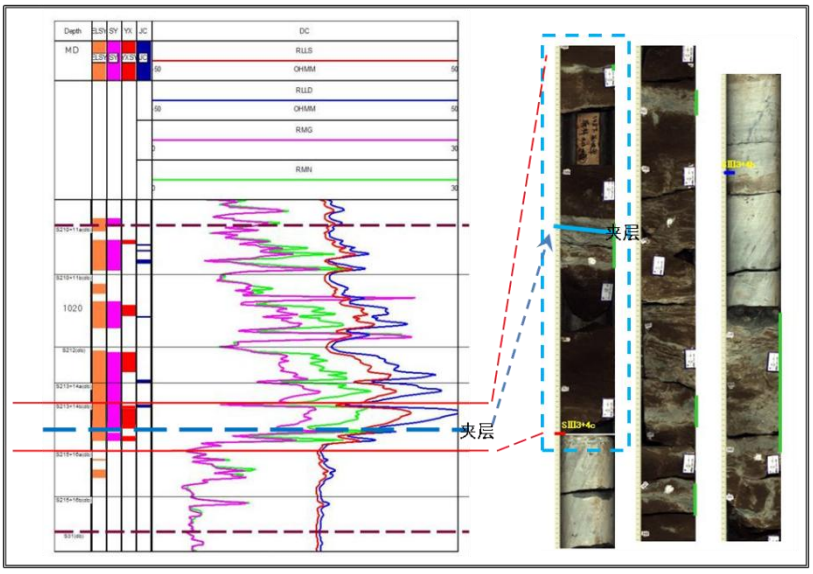

Fig.5： Diagrammatic sketch of core data determine the angle of sandwich

VI. CONCLUSION

There are a variety of methods in the process of extraction medial angle in point bar accretion , using core data to observe interbed dip is the most intuitive, most accurate, most close to the real value among them. In the preceding research methods, inclination calculated with three point method is the most close to the inclination observed with core data. It is said that interbed dip striking with three point method gets high accuracy.

In practical research,we will always face the lack of core data, it needs to adopt other methods to extract interbed dip, including subwells calculating method, wide-depth method, convex abandon surface method, river parameter method,among them, wide-depth method and river parameter method belongs to the empirical formula,so different sedimentary environment may cause some errors of extracting interlayer inclination. When striking interlayer inclination with subwells or convex abandon surface method,we won't always get the true dissection dip. Three point method will help us obtain true dip, therefore when lacking of core data, we select three point method for interface dip.

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