The Distribution and Seismic Prediction of Beach Bar Sandbodies in Narrow and Elongate Lacustrine Basin - A Case from Es2 in Chezhen Depression in the East of China*

Xia Luo[1], Mingyou Tan[1], and Yingge Chang [1]

Search and Discovery Article #50641 (2012)**
Posted July 3, 2012

*Adapted from oral presentation given at AAPG 2012 Southwest Section Meeting, Ft. Worth, Texas, 19-22 May 2012

[1]China Petroleum and Chemical Corporation (SINOPEC), Beijing, China (292947193@qq.com)

Abstract

The distribution of beach-bar sandbodies in narrow and elongate faulted basins is different from those in open basins. This study combined sedimentological and seismic reflection characteristics analysis to predict favorable exploration targets in a beach-bar complex in one of these basins. We classified beach-bar sand bodies in the basin into rework-dominated and transport-dominated types based on their genetic characteristics, and established sedimentary models for each type. The reworked type beach-bars are characterized by strong wave action with weaker offshore current transportation, while the transport-type beach-bars are characterized by strong offshore current transportation with weaker wave action, as indicated by the grain sensitive analysis, a measure of local hydrodynamic conditions.

The reworked beach bar sand bodies are the dominating facies in the area. Based on the established facies sequences, the seismic reflection characteristics and attributes related to these two types of sand bodies were analyzed. We found that a single (for instance, amplitude) attribute can reflect the thickness changes of reworked-type beach-bar sand bodies, while double (for instance, amplitude and frequency) attributes can be used to recognize the transport-type. This paper discussed methods in seismic prediction of sedimentary microfacies including the paleotopography recovering, attributes reconstruction, linear regression of frequency division, and frequency spectrum analysis. The prediction technique can distinguish beach and bar sand bodies in zones less than 5 m thick. The adoption of this innovative technology can improve the accuracy of beach bar sand body prediction by 20% ~ 25%, and the success rate of reservoir prediction from 60% ~ 75% to 85% ~ 90%.

中国石化
SINOPEC CORP.

The Distribution and Seismic Prediction of Beach Bar sand bodies in Narrow and Elongate Lacustrine Basin

— A case from Es2 in Chezhen Depression in the east of China

Xia Luo(Rose)

SINOPEC

OUTLINE

Introduction

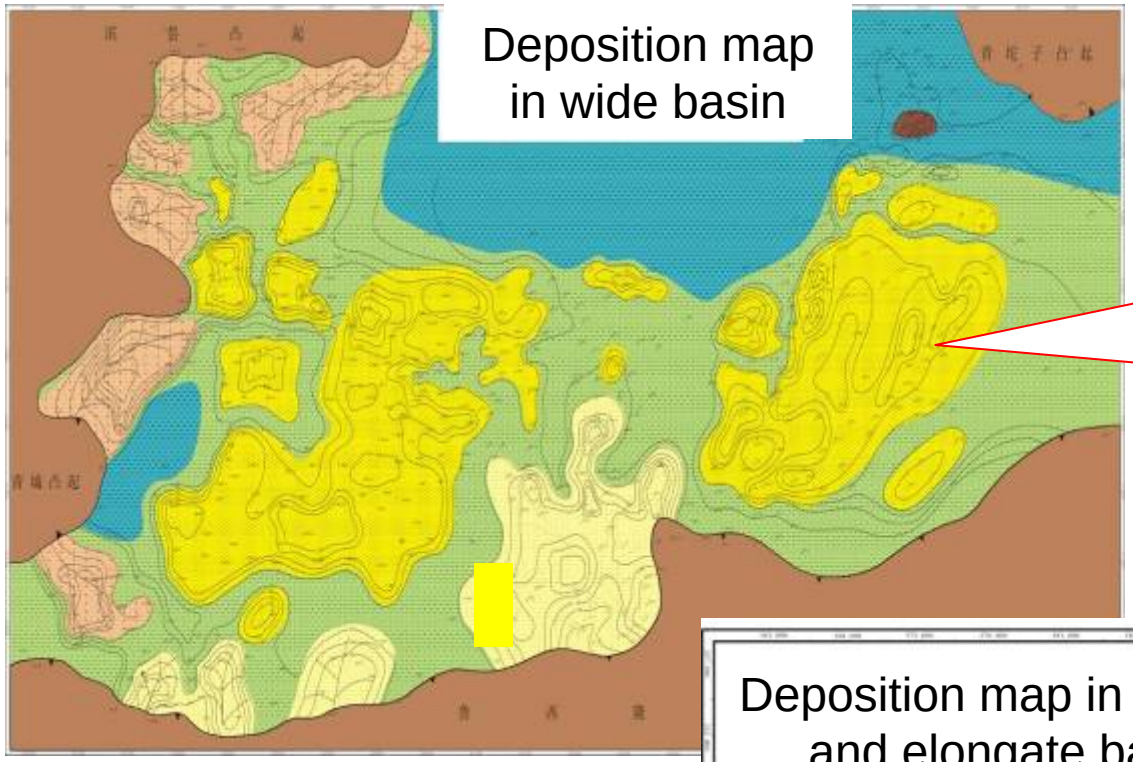
Genetic mode of beach bar sand bodies

Seismic prediction methods

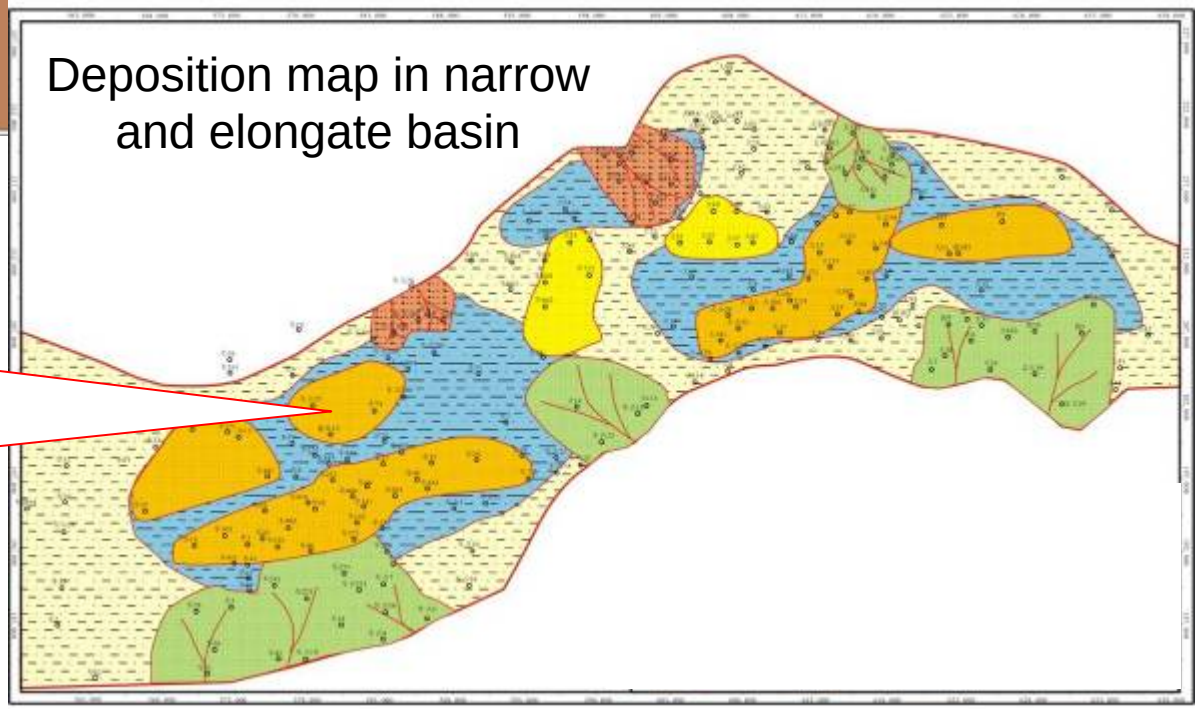
The effect of beach bar sand bodies exploration

Conclusions

1 Sedimentary Distribution is different.

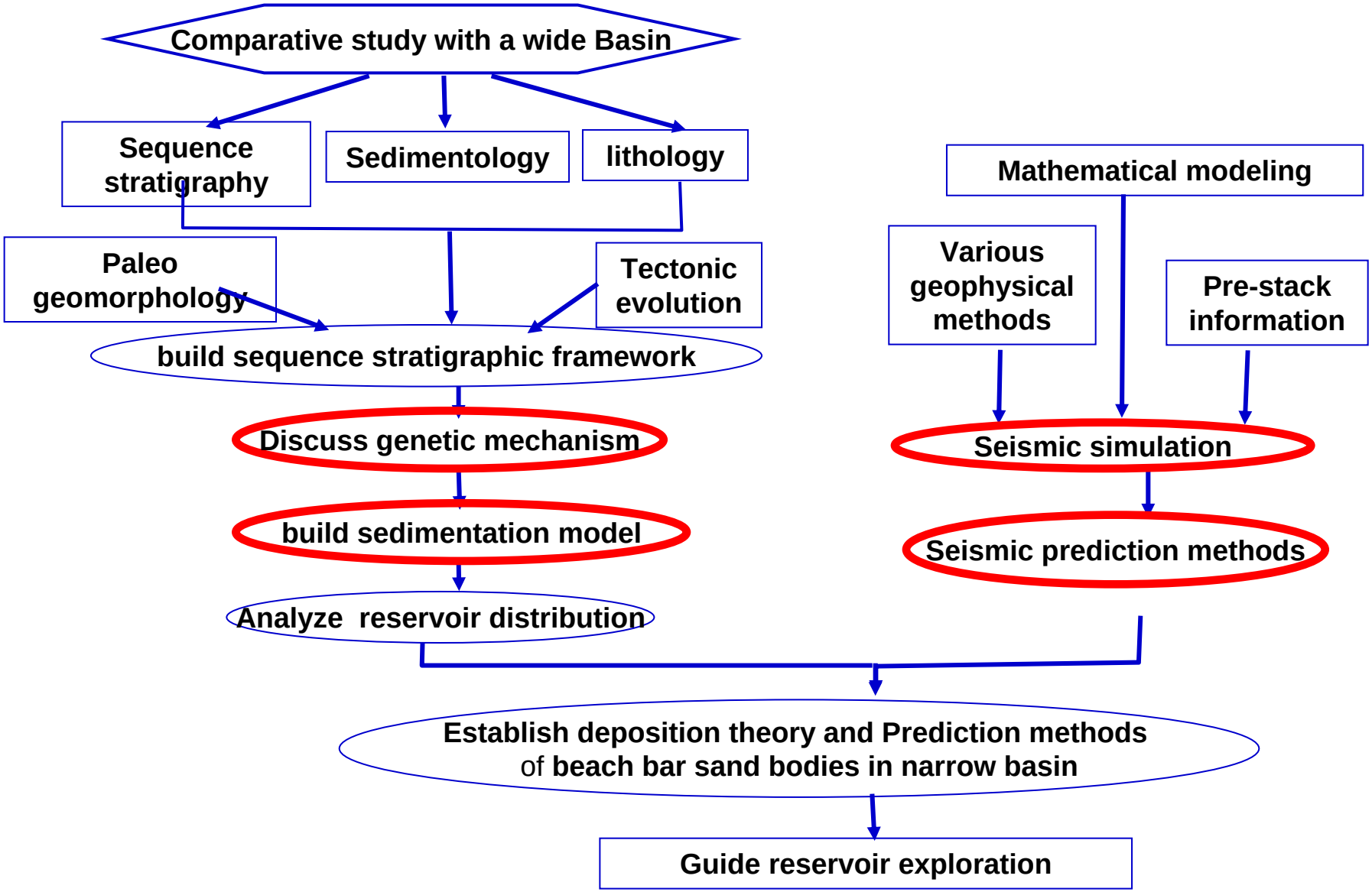


Wide basin: **The ratio of length to width is 2. sand bodies distribute in large areas and laterally continuous.**



Narrow basin: **The ratio of length to width is 4(for instance Chezhen Depression). sand bodies distribute in small areas and laterally discontinuous.**

Study workflow



OUTLINE

Introduction

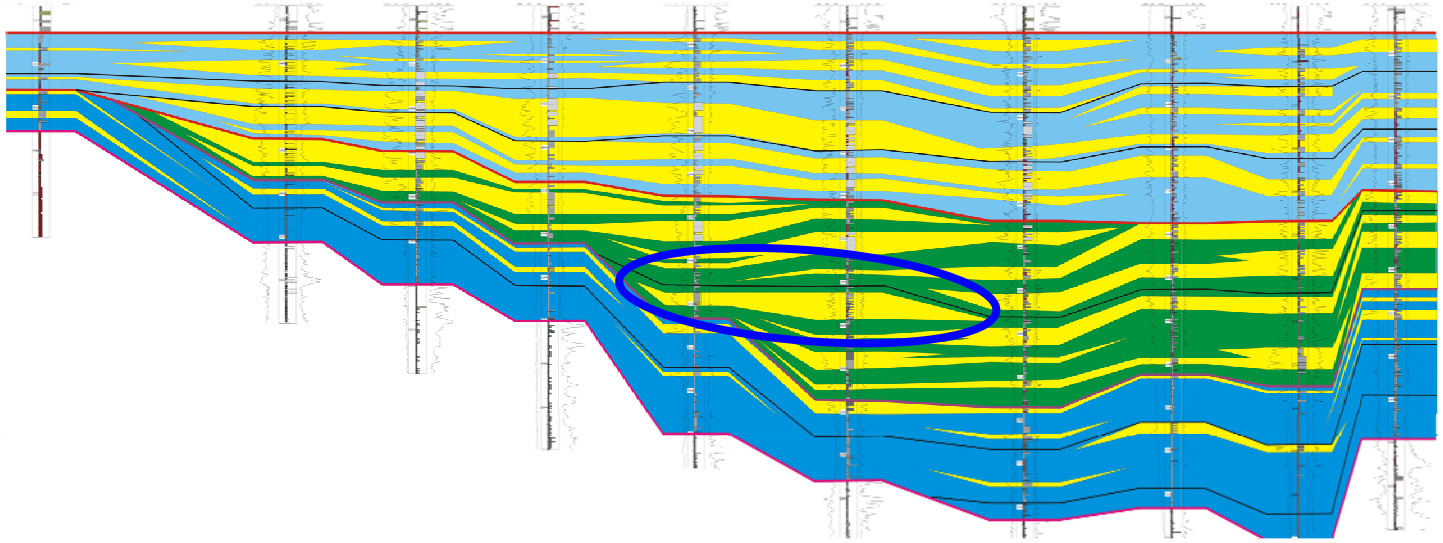
Genetic mode of beach bar sand bodies

Seismic prediction methods

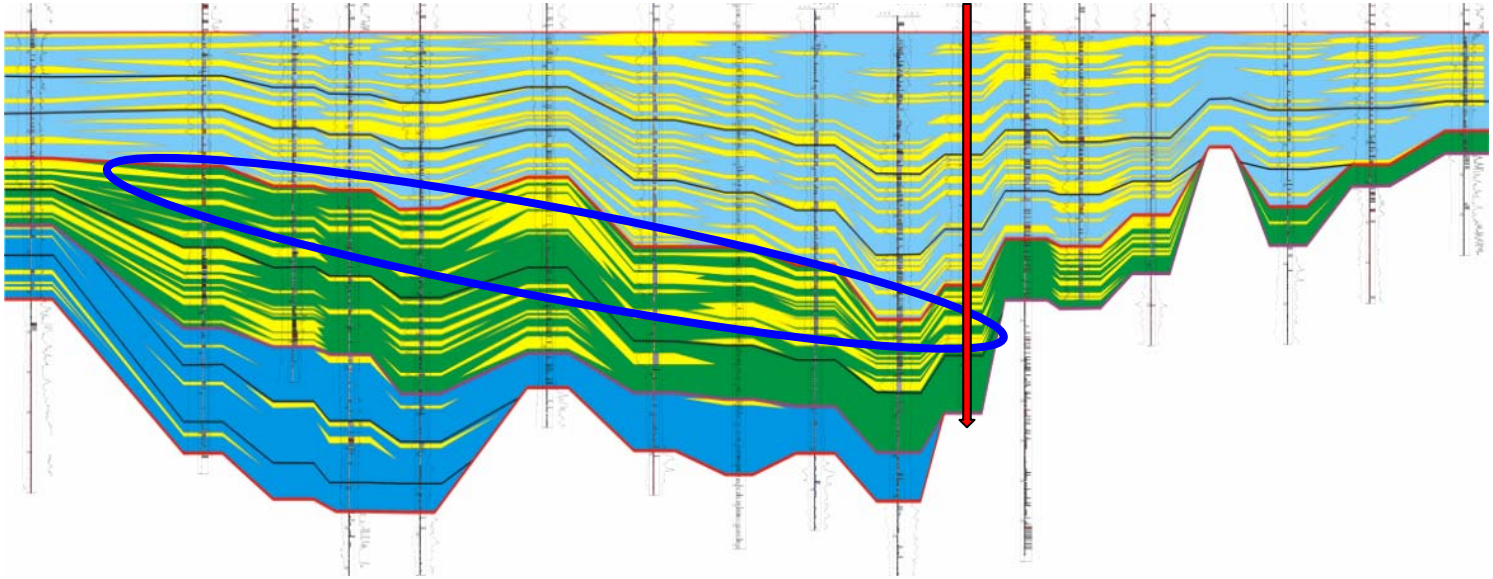
The effect of beach bar sand bodies exploration

Conclusions

NS stratigraphic profile of Es2

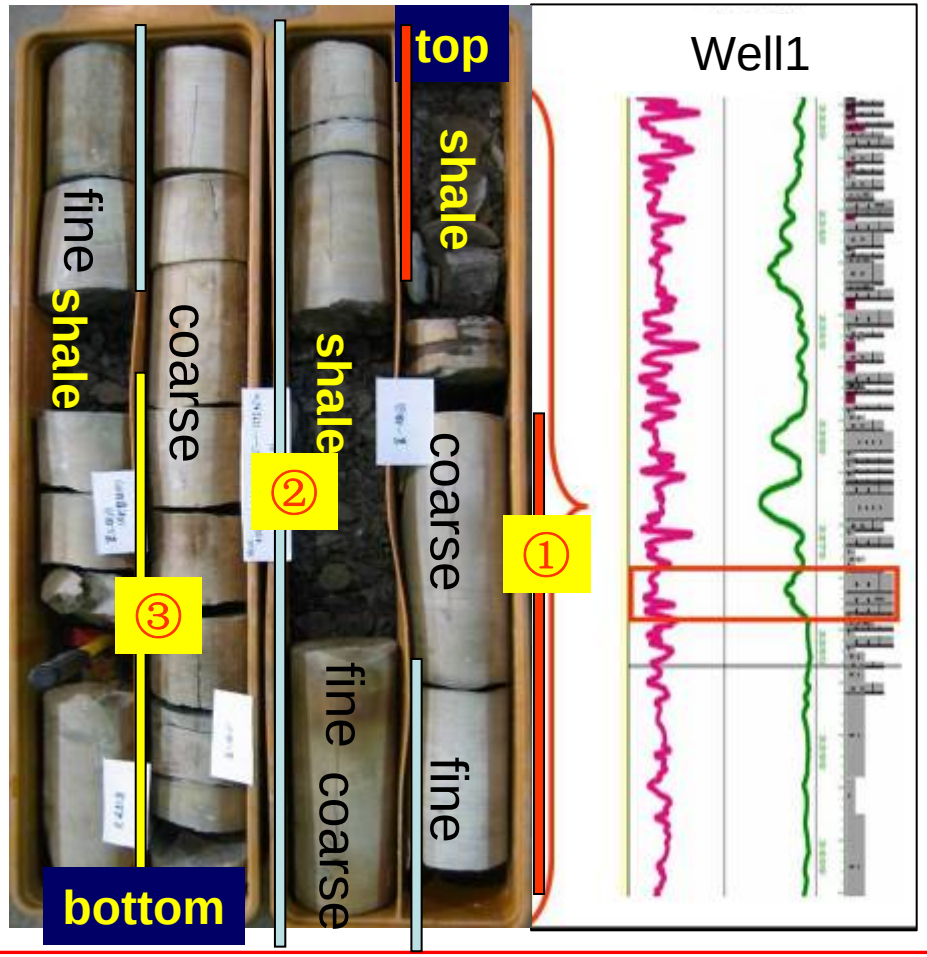


EW stratigraphic profile of Es2

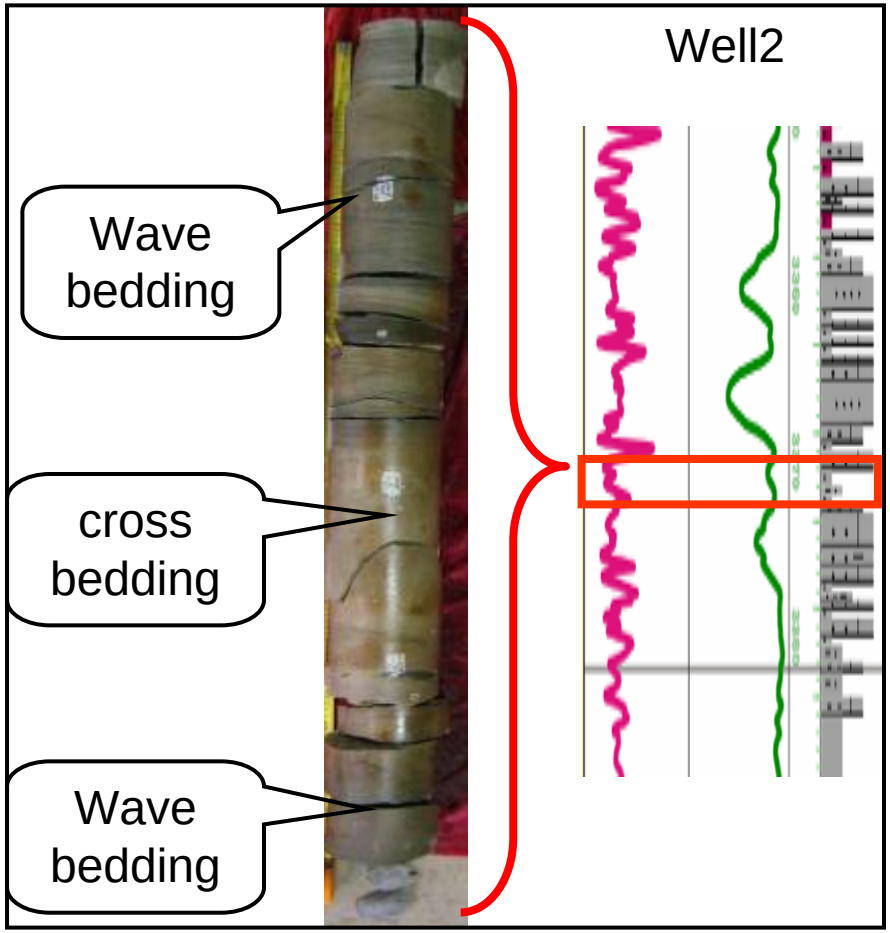


Sedimentary sequence characteristics

depositional sequence of bar
(3375.45m～3378.5m in Well1)



depositional sequence of beach
(3374m～3374.5m in Well2)

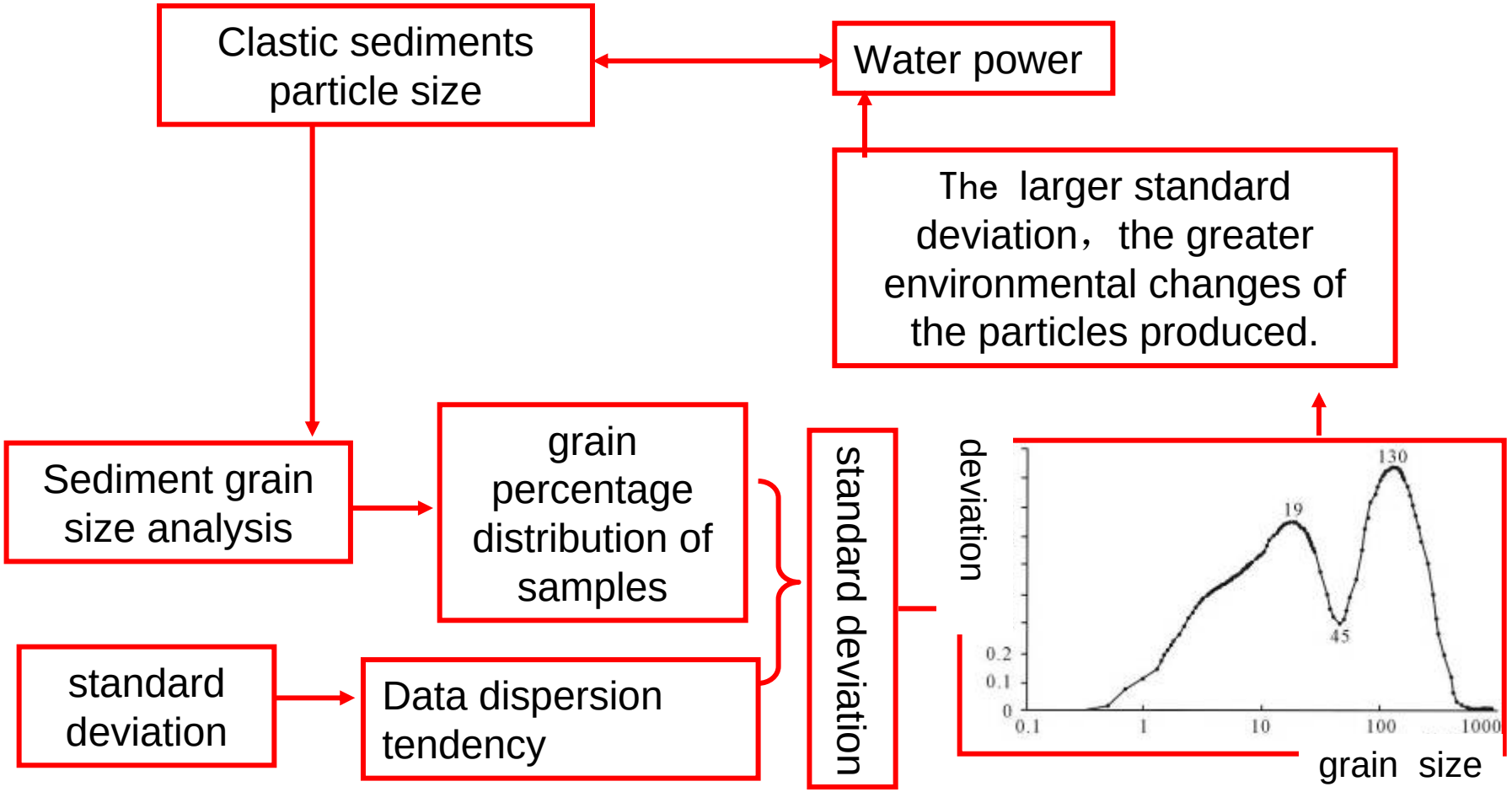


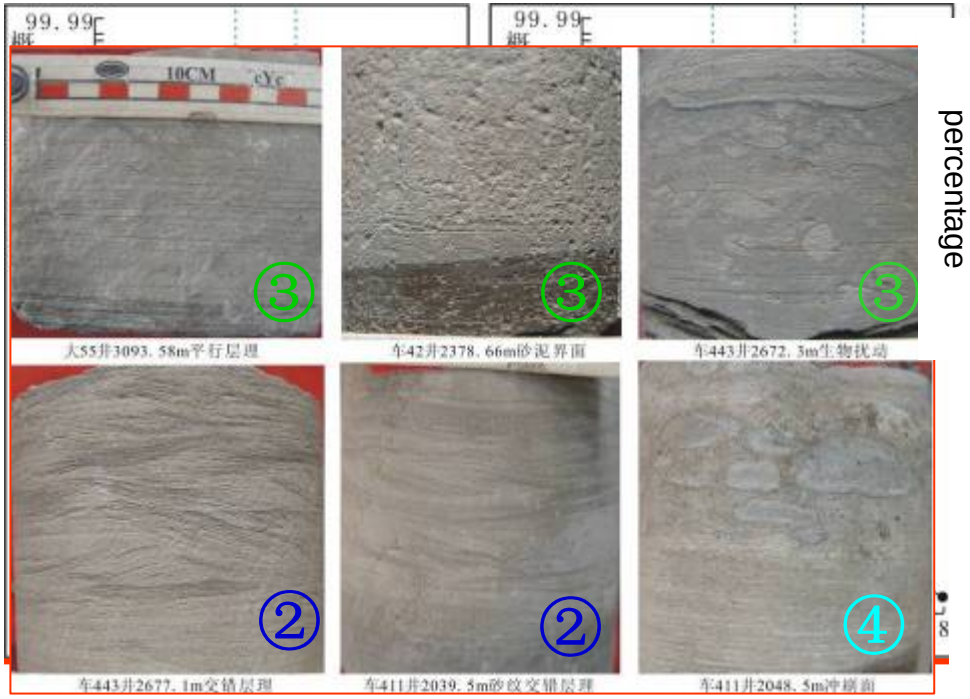
Bar sand's thickness is 5m~15m, often consisting of a plurality of anomal cycle or stacked by fine-coarse-fine symmetry cycle. The shape of AC or SP curve is "funnel" or "tongue".

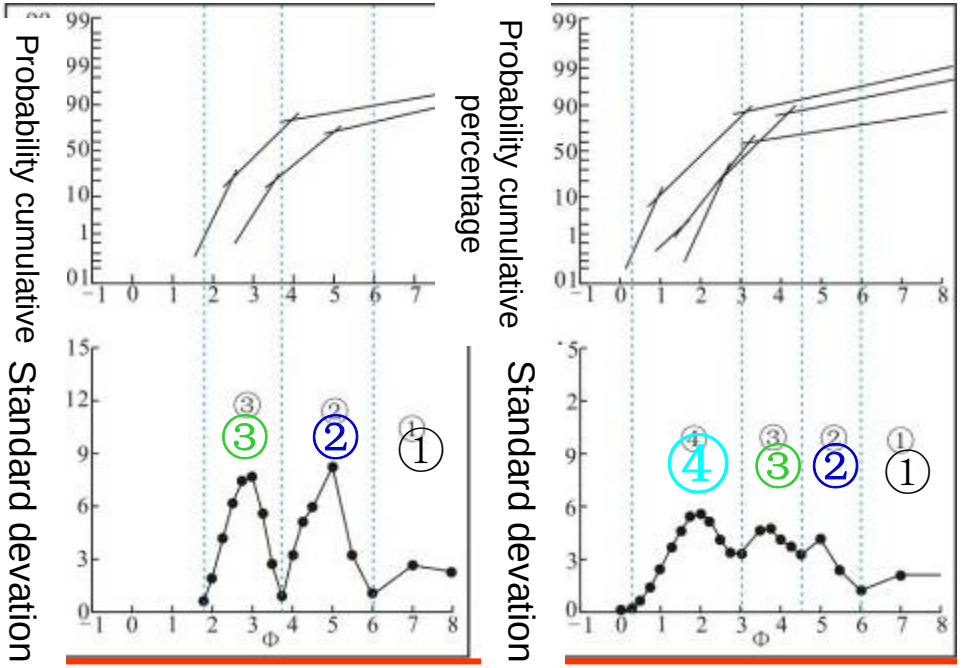
Beach sandstone thickness is 1m~ 2m. wave bedding, ripple and burrows are often seen. The cycle is anomal or symmetry. The shape of AC or SP curve is " finger" or" sawtooth".

Hydrodynamic condition analysis

- Methodology: grain-size analysis as Environment sensitive indicator
- Principal







There are four sets of environmentally sensitive grain size group.

①grain size <6 ϕ ,suspension transportationation；

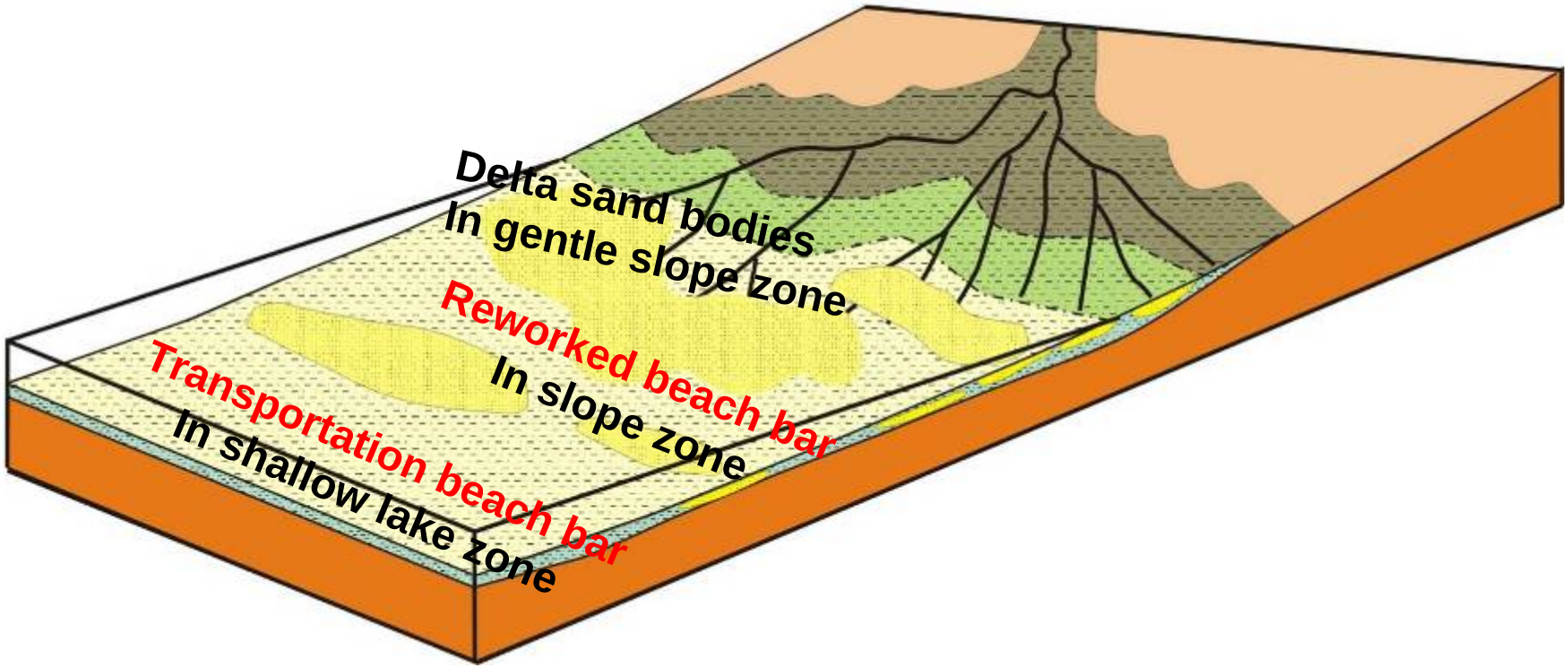
②grain size is 6 ϕ -4 ϕ ,longshore current；

③grain size is 4.25 ϕ -1.75 ϕ ,wave action；

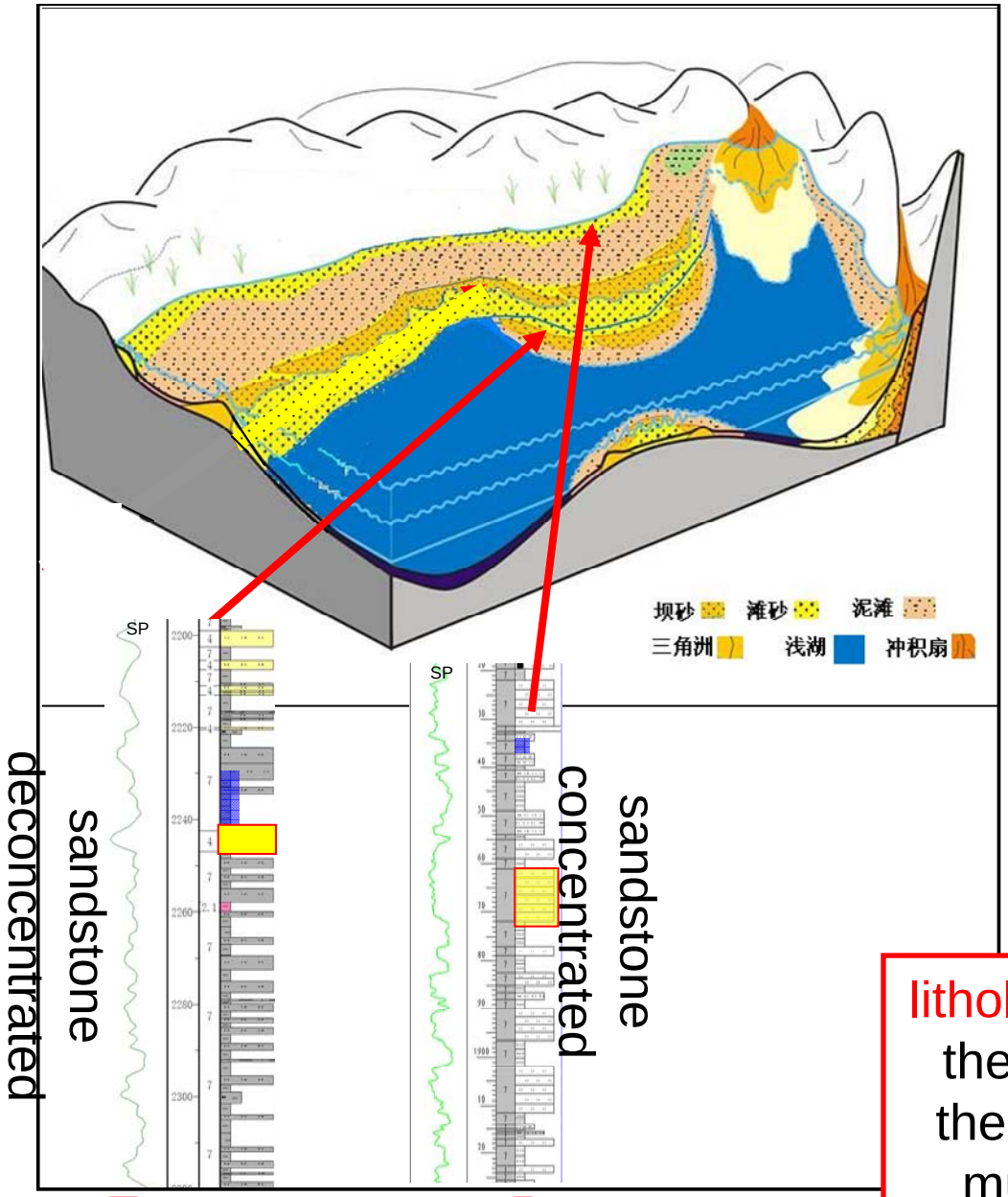
④ grain size 2.75 ϕ -1.25 ϕ ,underwater distributary channel fluid。

sets ② and ③ are main sets reflecting longshore current and wave repestively. They can be observed on the core.

Beach bar genetic deposition model



Lithology combination and distribution of different types of beach-bars



The thickness of bar sand and beach sand gradually become smaller from R type beach-bars to T type beach-bars, bar sand thickness from 10m~ 2.5m, beach sand thickness from 2m to 0.5m.

The thickness of mudstone interlayer becomes generally larger from R to T, about 3m ~ 8m.

lithologic combination properties：
the total thickness of sandstone, the number of sandstone layers, mudstone interlayer thickness

OUTLINE

Introduction

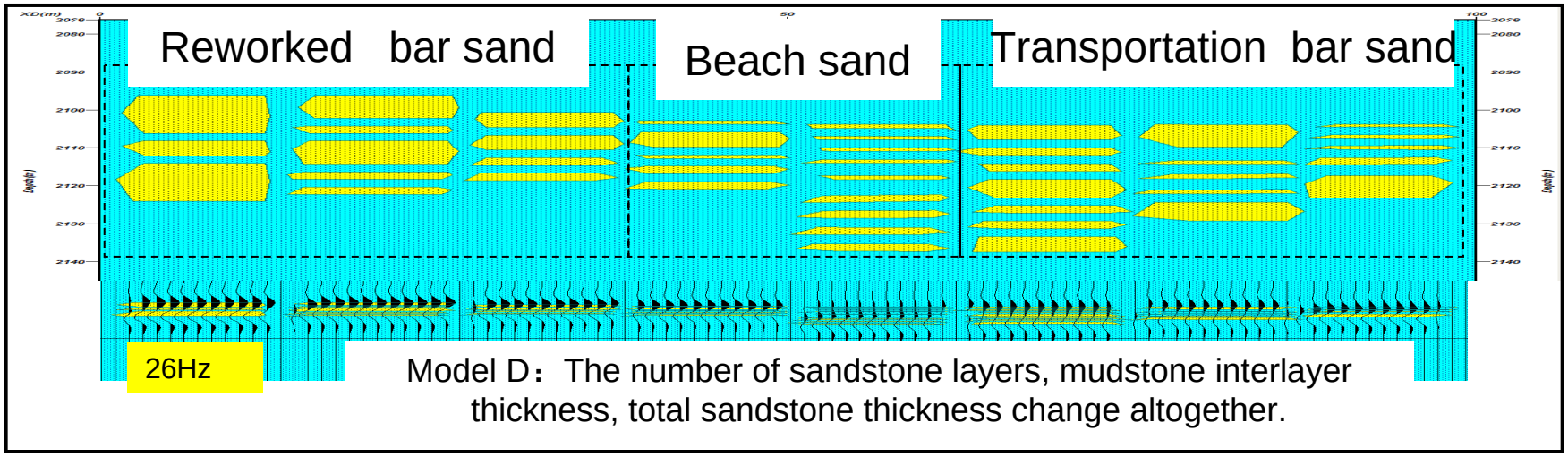
Genetic mode of beach bar sand bodies

Seismic prediction methods

The effect of beach bar sand bodies exploration

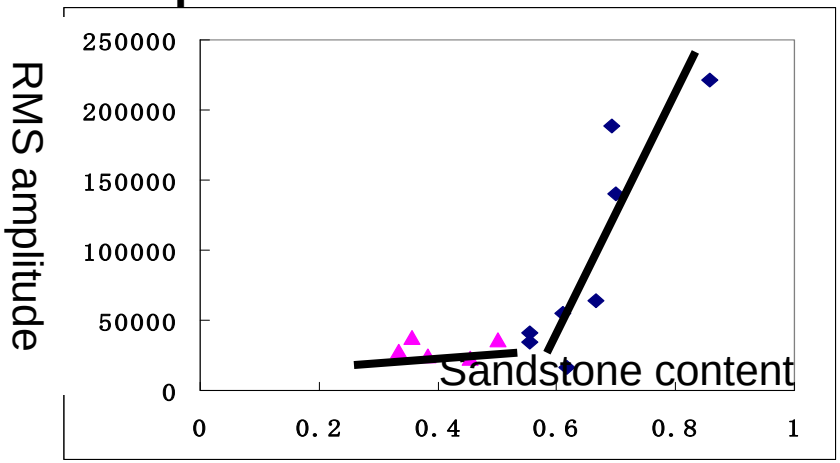
Conclusions

The ideal model of multiple properties change（Model D）

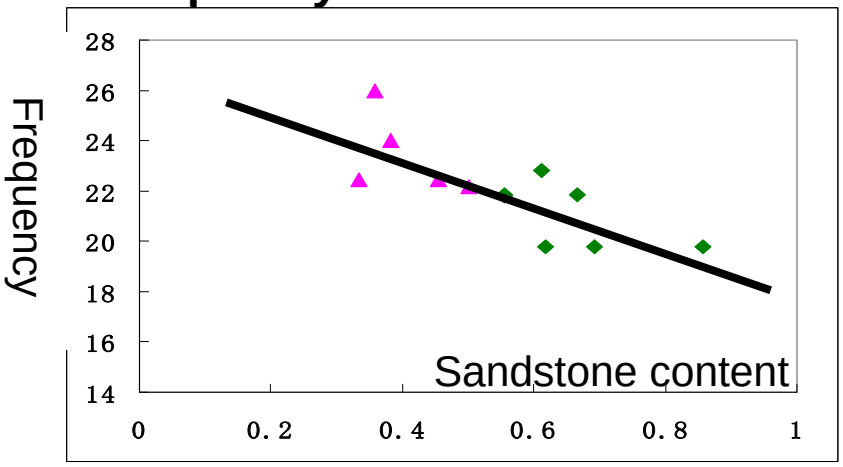


Model D：The number of sandstone layers, mudstone interlayer thickness, total sandstone thickness change altogether.

Amplitude – sandstone content



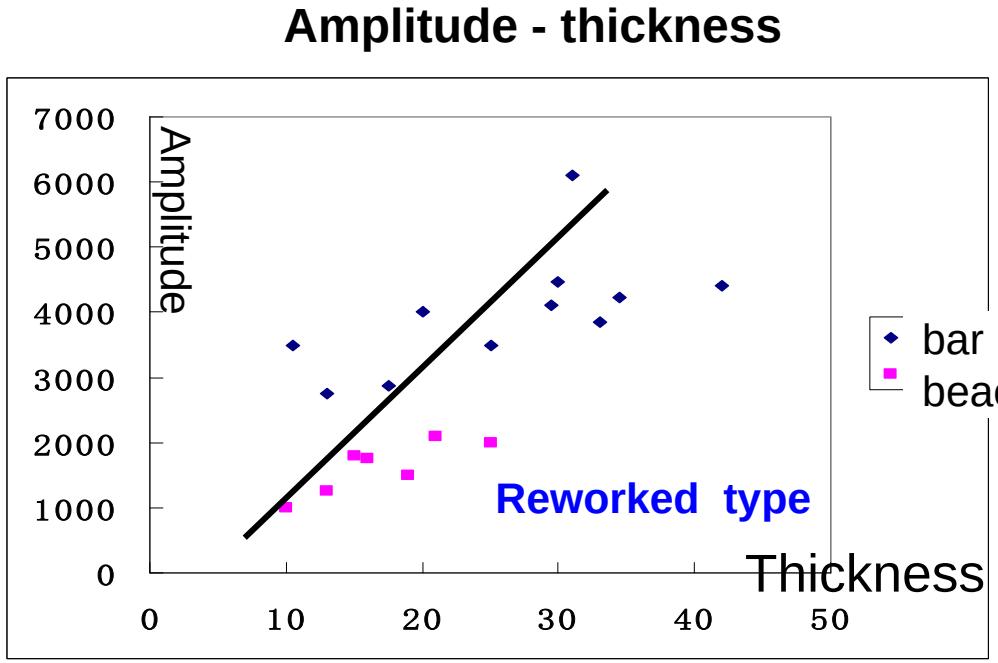
frequency – sandstone content

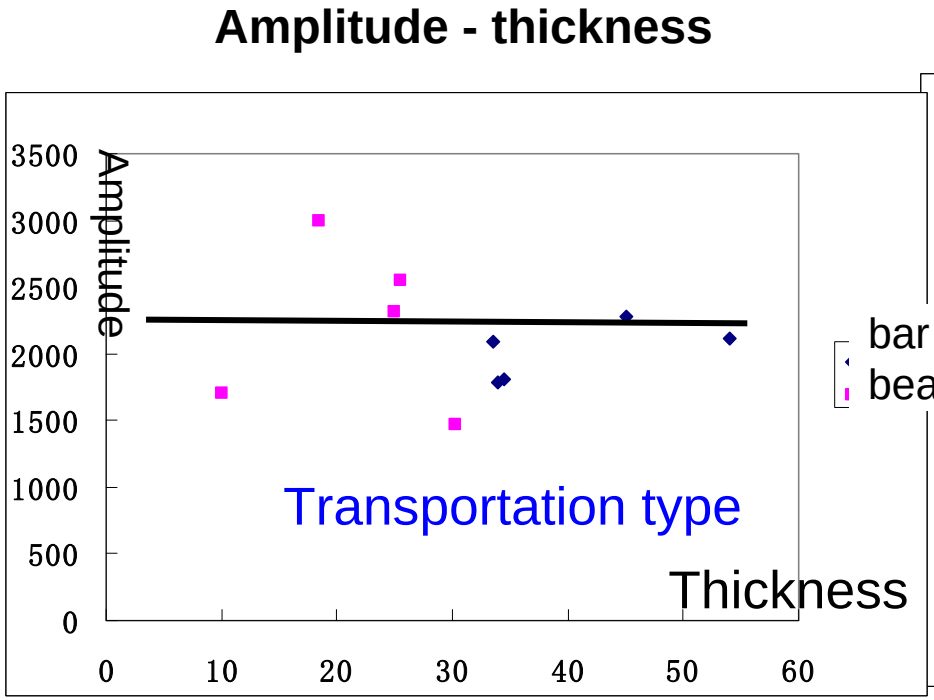


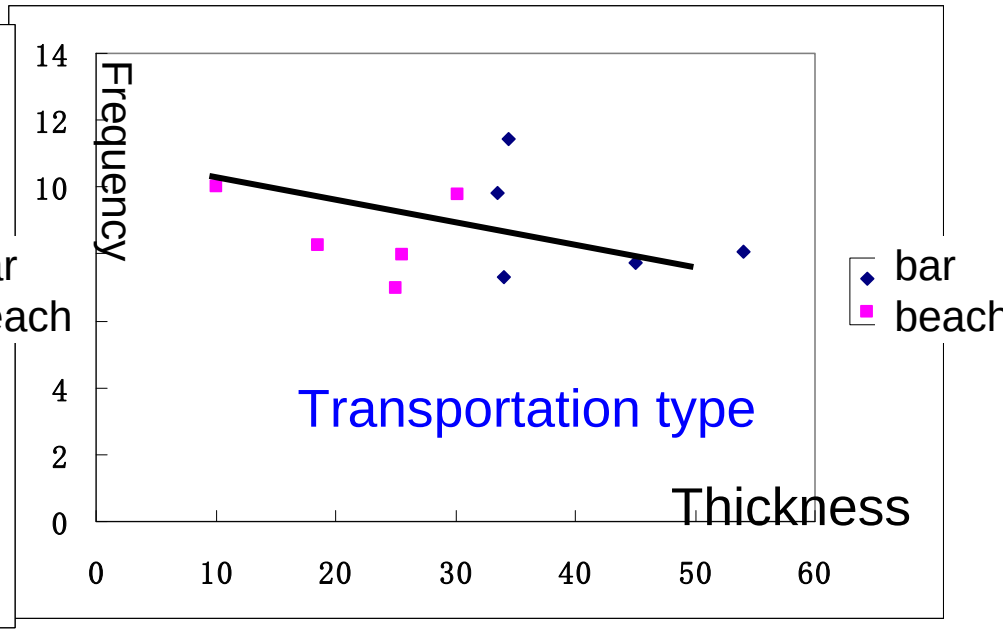
Model D

R type：single attribue

T type：double attributes







OUTLINE

Introduction

Genetic mode of beach bar sand bodies

Seismic prediction methods

- Multiple attributes reconstruction
- Linear regression frequency spectrum decomposition
- Spectrum contribution method
- Pre-stack attributes detecting hydrocarbon

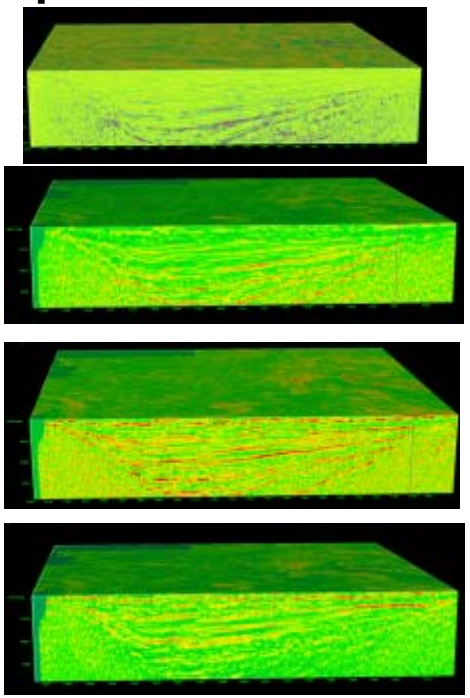
The effect of beach bar sand bodies exploration

Conclusions

Spectrum contribution

$$\text{The energy contribution （%）} = \frac{Ei}{\sum Ei}$$

Single frequency spetrum volume



15hz

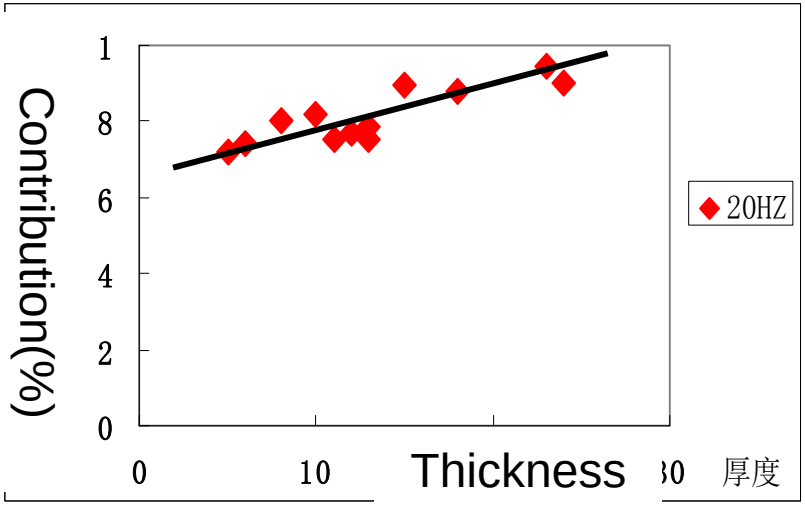
20hz

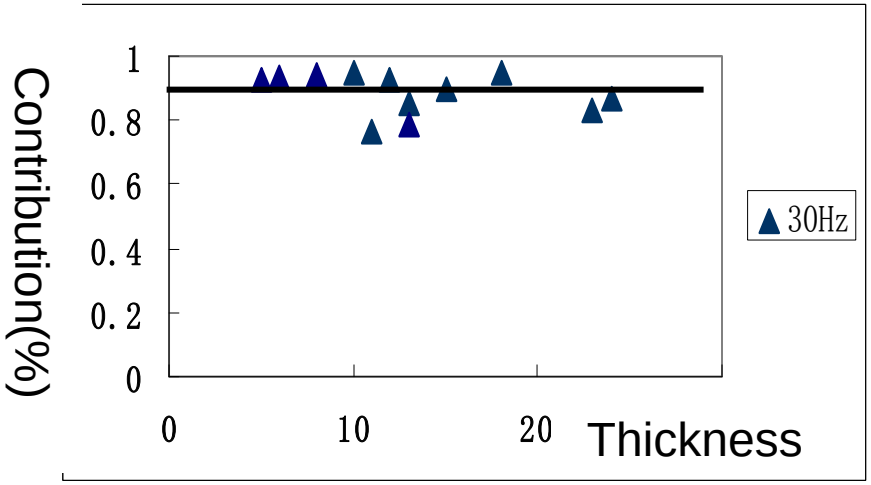
25hz

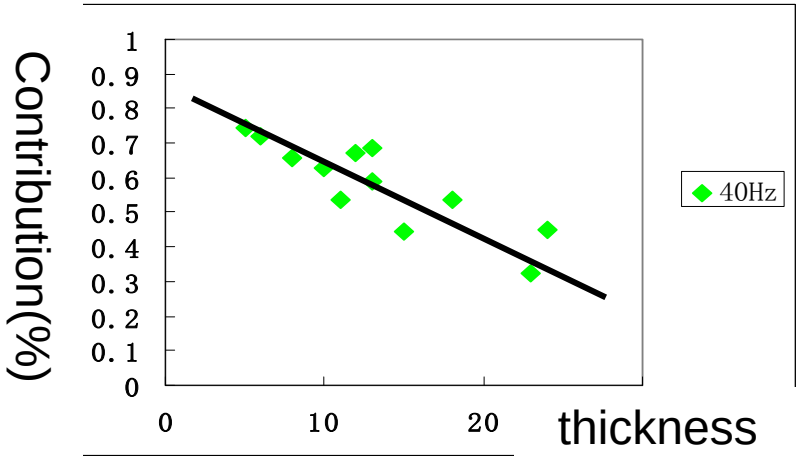
30hz

After Spectrum decomposition the correlation between the energy contribution percentage and bed thickness can be determined, then reservoir thickness prediction result can be achieved.

The correlation of frequency spectrum contribution(%) and sandstone thickness

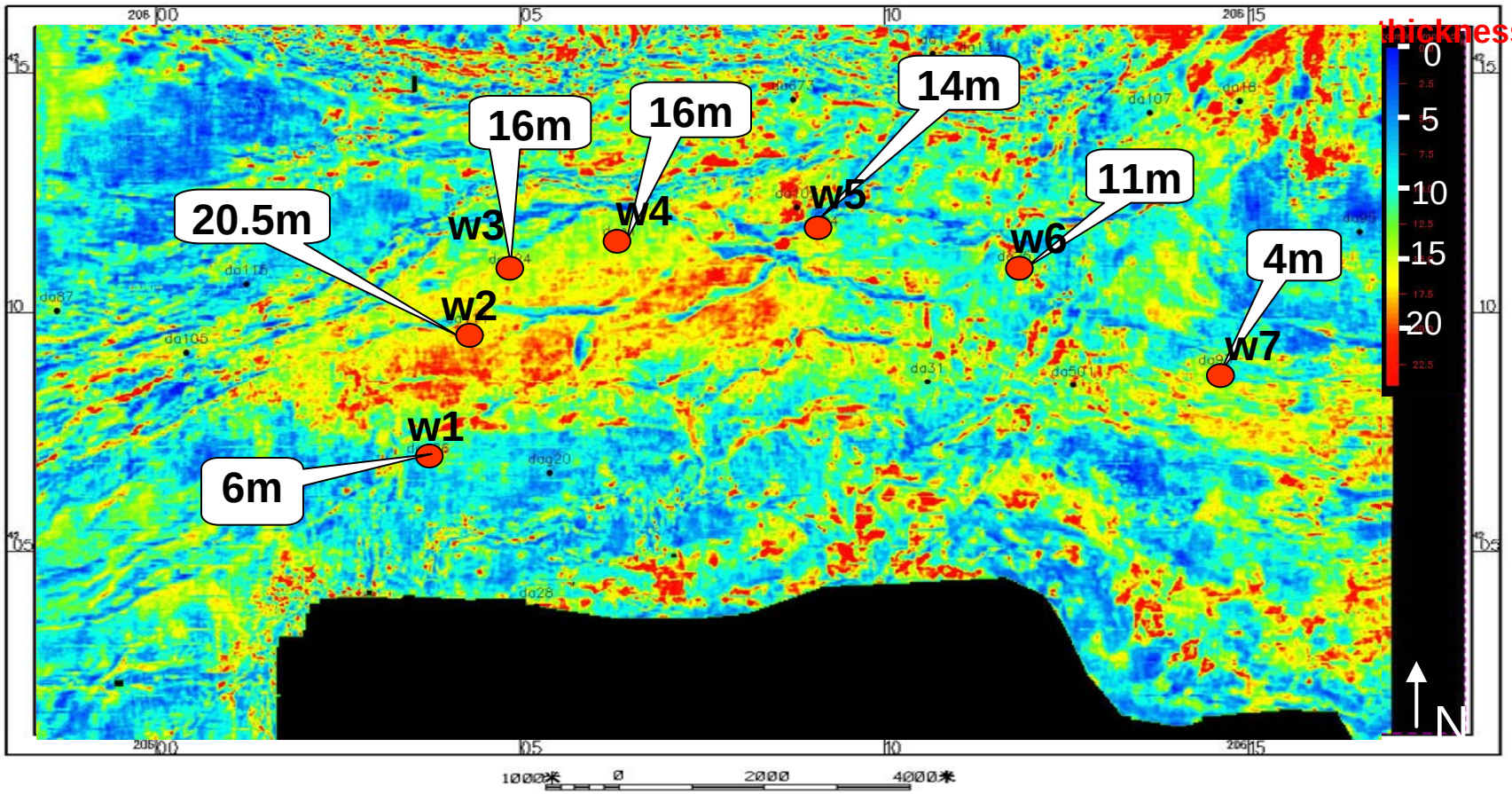






Red, yellow, green and blue represent the main bar, bar side edge, beach, inter beach facies and mudstone. The prediction accuracy of microfacies and thickness is 90% compared with drilling data.

The R type sandstone reservoir thickness(m) of $Es2^{1+2}$



OUTLINE

Introduction

Genetic mode of beach bar sand bodies

Seismic prediction methods

The effect of beach bar sand bodies exploration

Conclusions

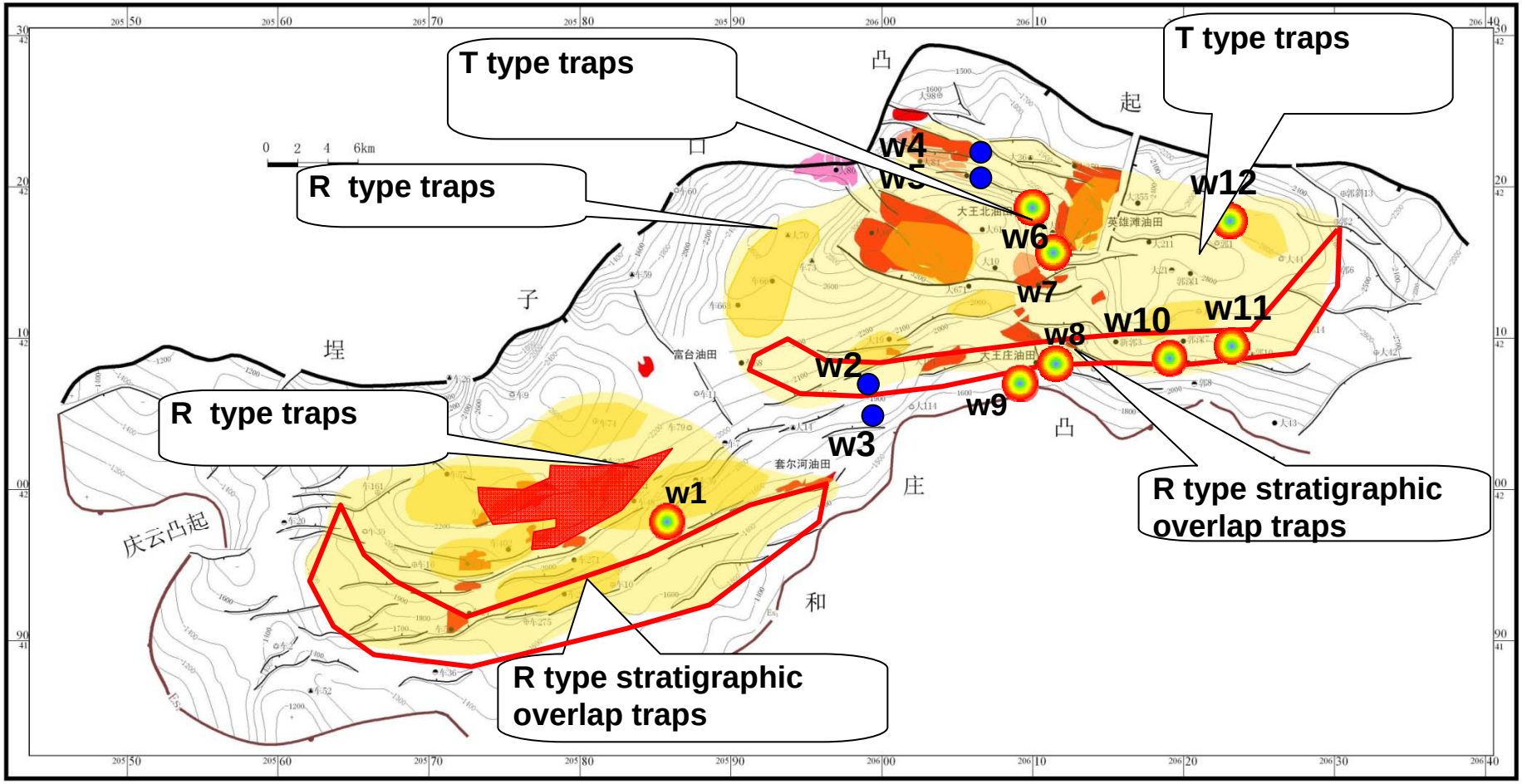
Summary of methods application result

The comparison table of new methods and old methods

old technique	prediction accuary	new technique	prediction accuary	prediction effeciency
amplitude	60%	Multiple attributes reconstruction	85%	predict bar zone and beach zone
time slices	60%	Linear regression frequency spectrum	92%	recognize microfacies of beach bar
seiemic facies	65%	spectrum contribution percentage prediction	94%	predict bar and beach thickness
frequency decompostion	75%	Pre-stack attributes detecting hydrocarbon	>90%	predict oil-bearing area

The new prediction methods can distinguish beach and bar sand bodies microfacies and predict zone of less than 5m in thickness, The adoption of this innovative technology can improve the prediction accuracy of beach bar sand bodies by 20% ~ 25%

Beach bar sand bodies and the oil distribution



A total of 12 wells are proposed and drilled, in which 6 wells found oil flow. Another important discovery is that there are stratigraphic overlap reservoirs on the high position of gentle slope which is the breakthrough.

Conclusions

（1）The beach bar sand bodies in narrow and shallow lacustrine can be divided into reworked type and transportation type.

（2）according to the established facies sequences and model numerical simulation, the single (for instance, amplitude) attribute can reflect the thickness changes of reworked type beach bar sand bodies, while double (for instance, amplitude and frequency) attributes can be used to recognize the transportation-type.

（3）The prediction accuracy using innovative technology can be improved by 20% ~ 25%.