



中国石油大学 (华东)  
CHINA UNIVERSITY OF PETROLEUM

2nd International Conference and Expo on

**Oil and Gas**

## **Characters Of Sedimentary Facies And Main Control Factors In Upper Fourth Member Of Shahejie Formation In Qingnan Sub-sag**

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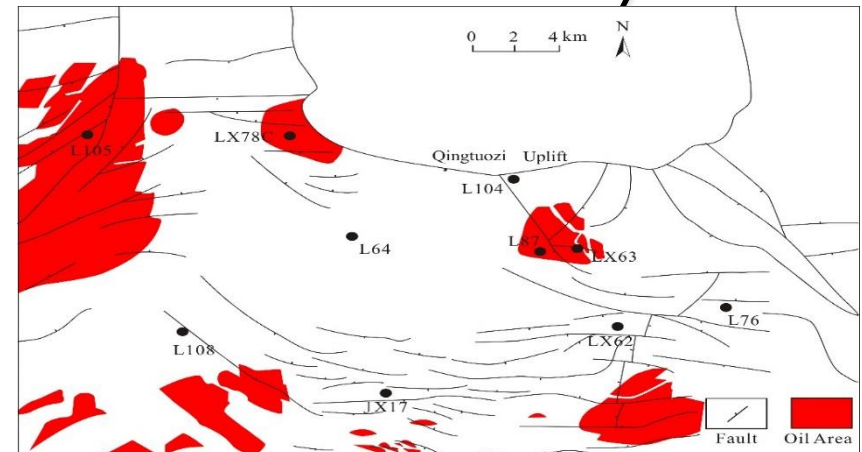
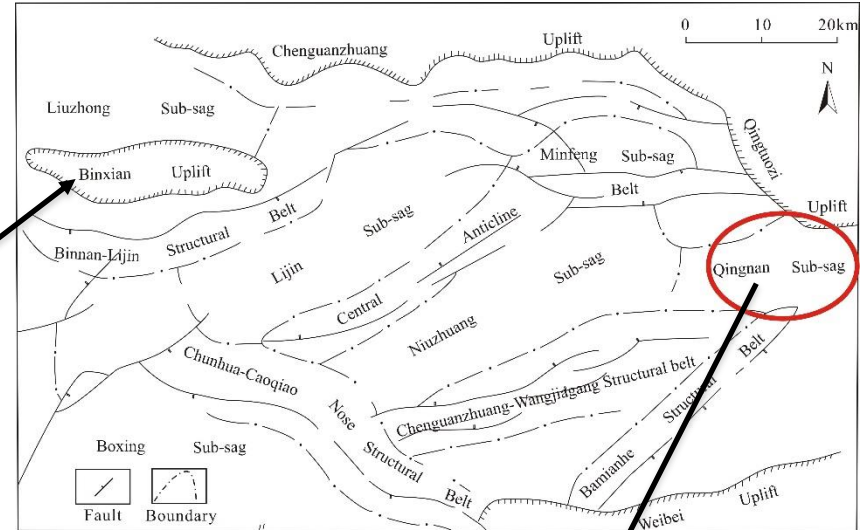
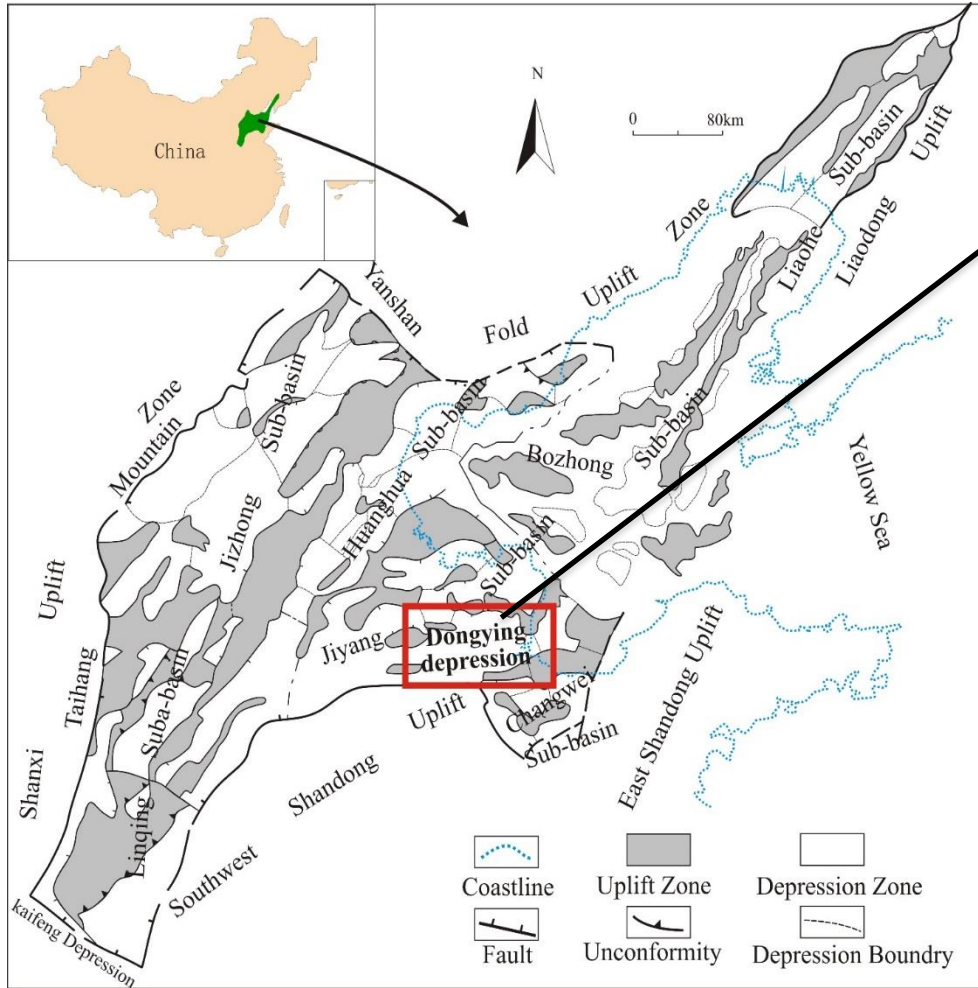
October 27<sup>th</sup>, 2016 in Rome, Italy



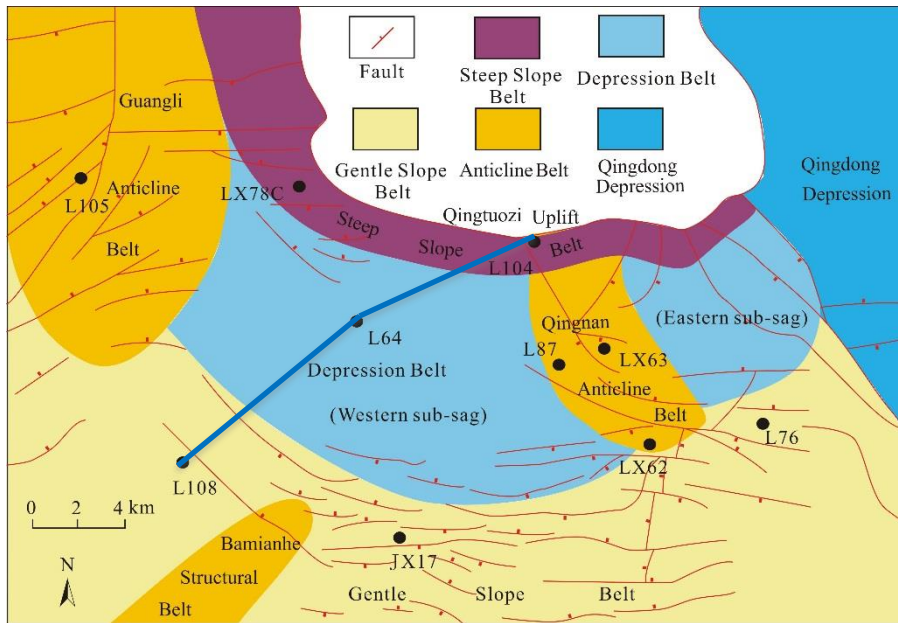
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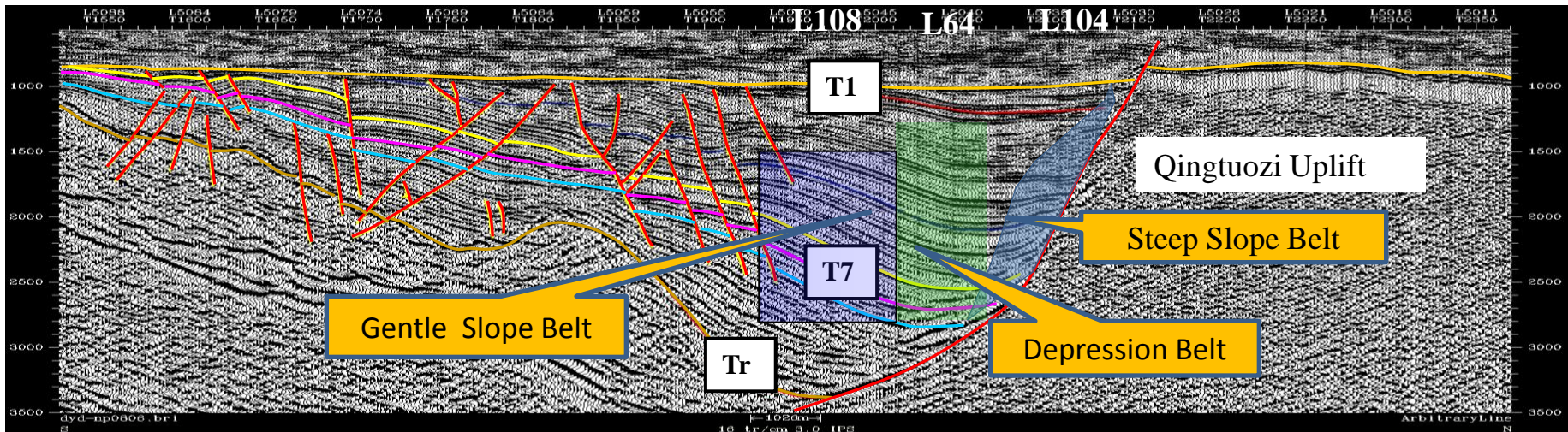
# 1、 Geological Background in study area



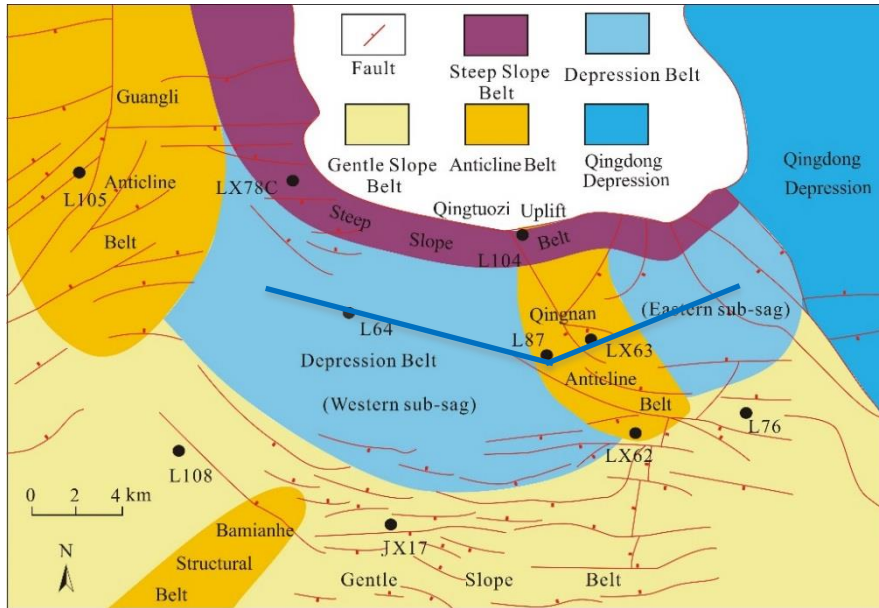
The study area located in northern Shandong coastal area, in Shengli Oilfield, Dongying city, China.



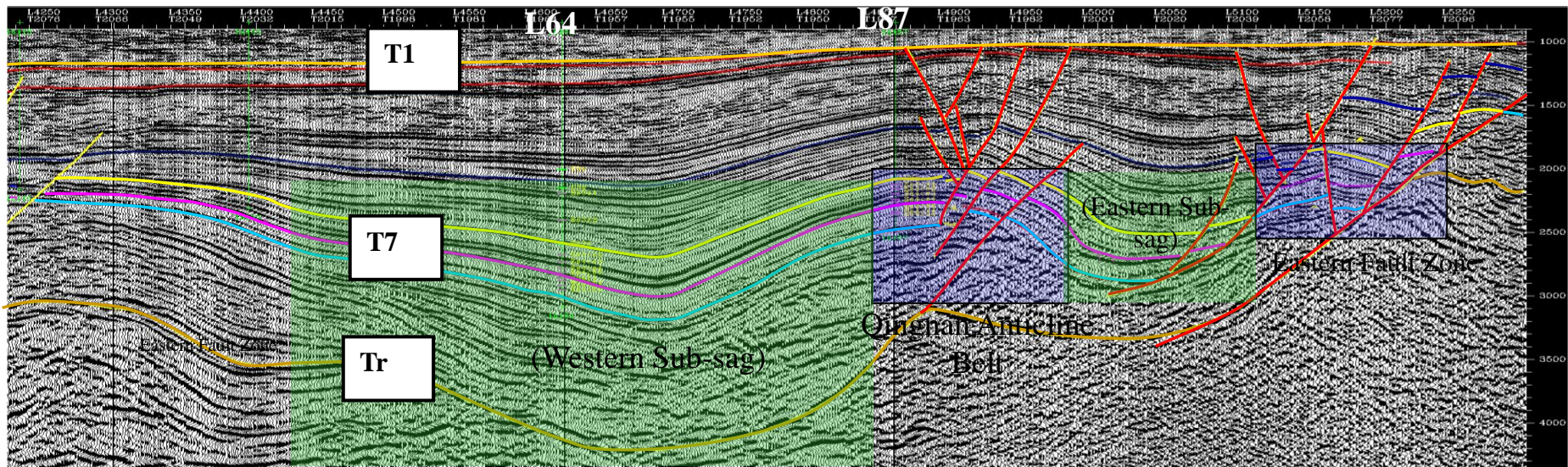
It is a typical north and south steep slow sub-sag, the exploration area is about 300km<sup>2</sup>. Nowadays, it has 19 drilling wells, including 13 wells drilling in oil, the oil reserves is  $916.67 \times 10^4$ t.



North-south Seismic Section of Qingnan Sub-sag



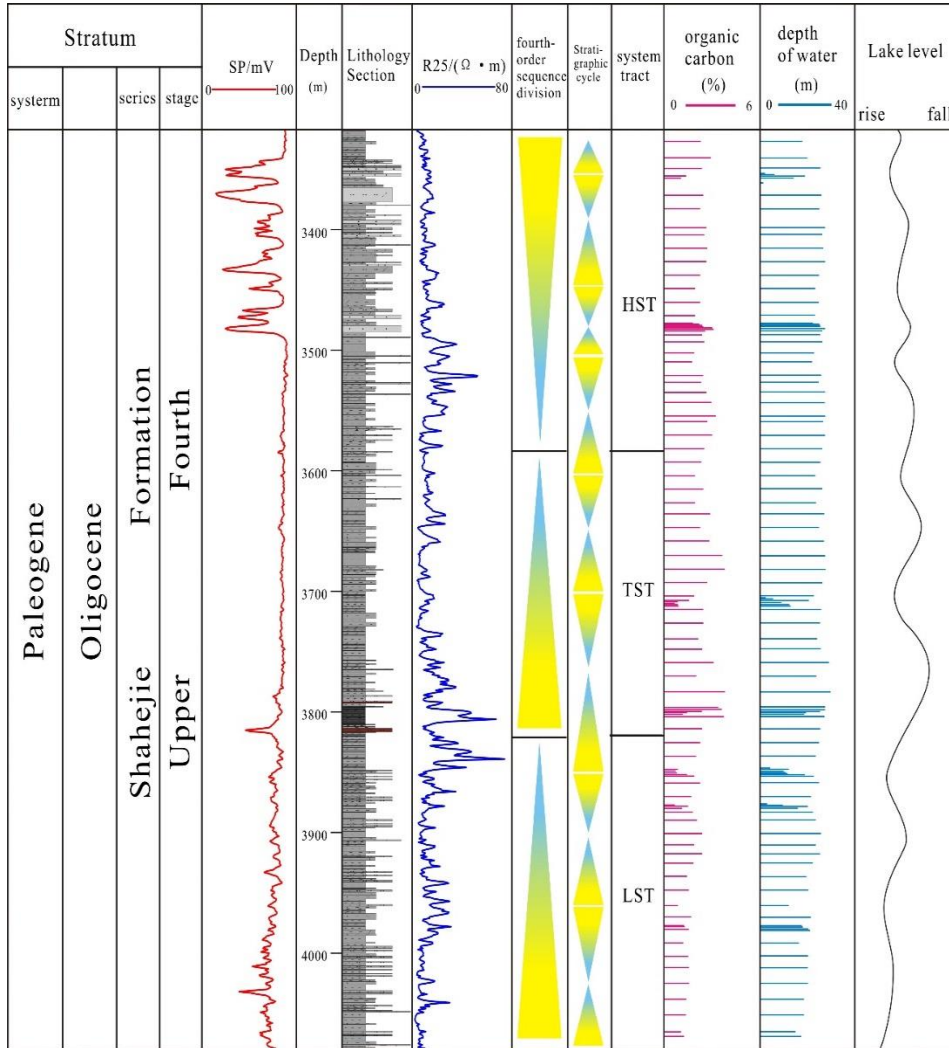
From west to east, divided into two sub-sags and two uplifted zones, which are western sub-sag, qingnan anticline belt, eastern sub-sag and eastern fault zone.



East-west Seismic Section of Qingnan Sub-sag



## 2、 The characteristics of sedimentary in Qingnan subsag



the sub-sag can be divided into three system tracts, including LST, TST, HST. The whole composition style of short-term base level cycle is mainly asymmetric cycle. And there are some differences among interface characteristics, thickness of cycle, grain size of sediments and structure in different cycles. Through core description of the coring interval, and combined with its comprehensive analysis with the results of well log curve of calibration, the composition of each sequence in the medium-term base level cycle style is mainly about datum up half cycle and datum down half cycle

Sequence classification of the upper Es<sup>4</sup> in Qingnan Sag

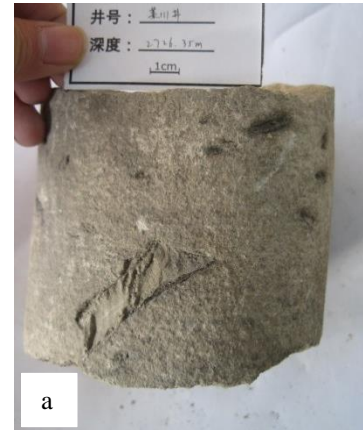


Stratum			Depth (m)	GR 30——100	Lithology Section	Analysis of Facies			Core Image	
system	series	stage				Facies	Sub-Facies	Micro-Facies		
Paleogene	Shahejie Formation	Upper	2724		1	Fan	Delta	Plain	back marsh	a
			2725		2				braided distributary channel	
			2726		2				braided distributary channel	
		2727		1	Delta		back marsh			
		2728		2	Fan		braided distributary channel	b		
		2729		2	back marsh					
2730		2	braided distributary channel							
2731		1	Delta	back marsh	c					

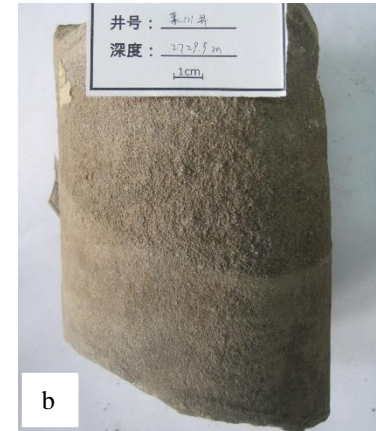


1 contain coarse sandstone 2 calcareous sandstone 3 siltstone 4 mudstone

sedimentary facies of well L111  
(fan delta plain)



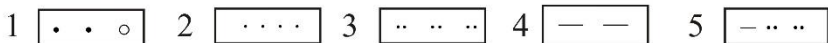
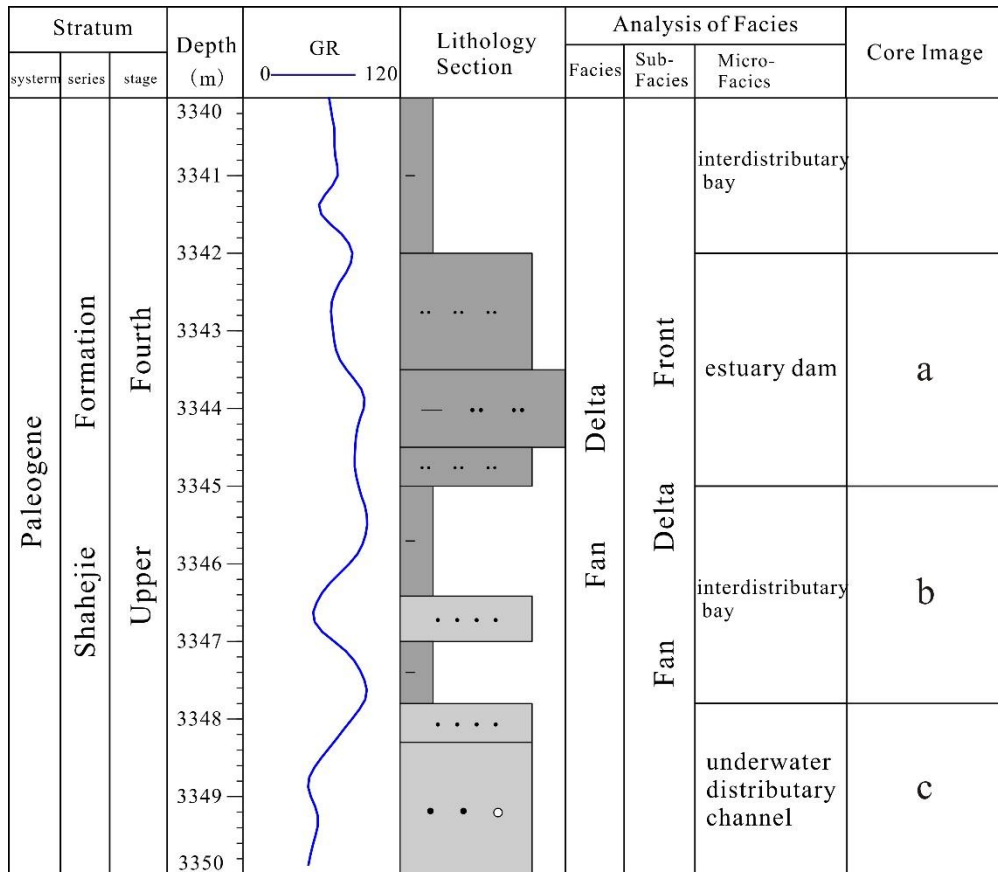
2726.65m,,boulder clay



2729.3m,scour surface

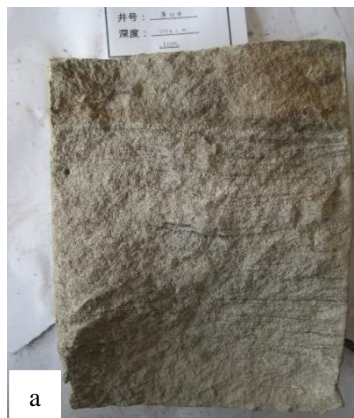


2730.25m, carbon dust

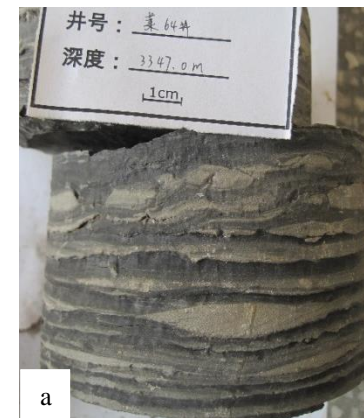


1 contain coarse sandstone 2 fine sandstone 3 siltstone 4 mudstone  
4 argillaceous siltstone

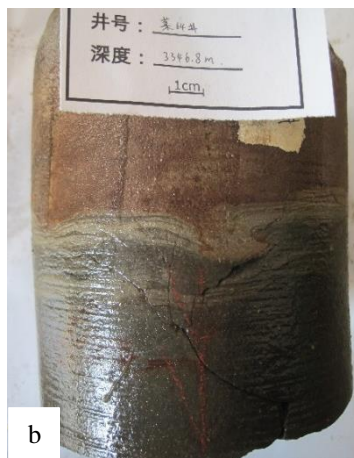
sedimentary facies of well L64  
(fan delta front)



3344.2m, parallel bedding in bottom cross bedding on top



3347.0m, lenticular bedding



3346.8m, load cast



3350m, scour surface in bottom



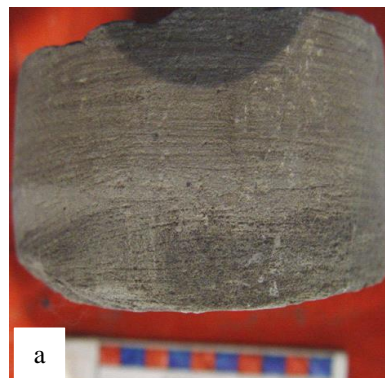


Stratum			Depth (m)	GR 0 — 120	Lithology Section	Analysis of Facies			Core Image	
system	series	stage				Facies	Sub-Facies	Micro-Facies		
Paleogene	Shahejie	Upper	2640			Delta	Delta	Front	estuary dam	a
			underwater interdistributary bay							
			2641						estuary dam	b
			2642						underwater interdistributary bay	
	2643	underwater distributary channel	c							
	2644	underwater interdistributary bay								
	2645	estuary dam								
	2646	estuary dam								
2647	estuary dam									
2648	estuary dam									

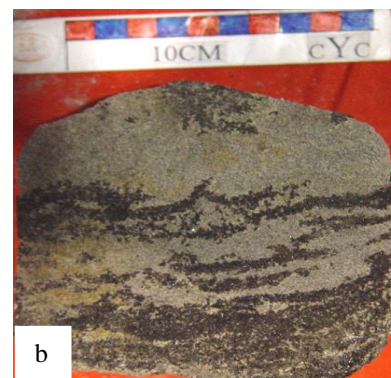
1 2 3 4   
 1 contain coarse sandstone 2 fine sandstone 3 sandy mudstone  
 4 mudstone

sedimentary facies of well L108

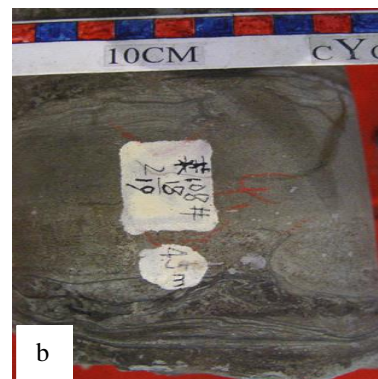
(delta front)



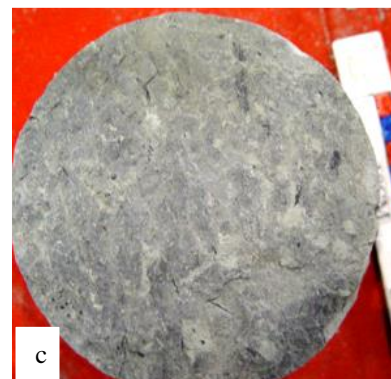
2641.4m, sand grain bedding



2645.1m, trough cross-stratification



2645.4m, flamboyant structure



2646.8m, bioturbation



Stratum			Depth (m)	GR 0 — 120	Lithology Section	Analysis of Facies			Core Image
system	series	stage				Facies	Sub-Facies	Micro-Facies	
Paleogene	Shahejie	Upper	3813			Lake	Shore-shallow Lake	beach-bar sand	a
			3814						
			3815						
			3816						
	Shahejie	Lower	3817			Semi-deep Lake	mud flat	b	
			3818			Shore-shallow Lake	beach-bar sand		
			3819						

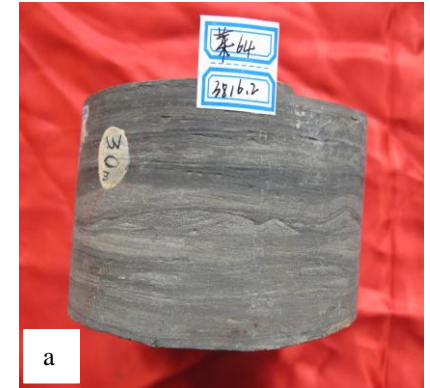
- 1 2 3 4   
5 6 7

1 lime mudstone 2 siltstone 3 sandy mudstone 4 mudstone  
5 dolomitic sandstone 6 silty mudstone 7 oil shale

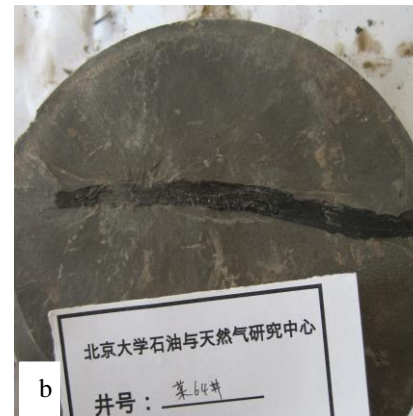
sedimentary facies of well L64  
(lake)



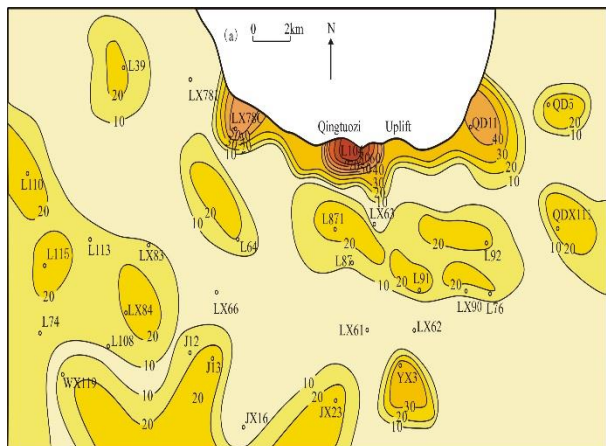
3813.6m, the massive bedding



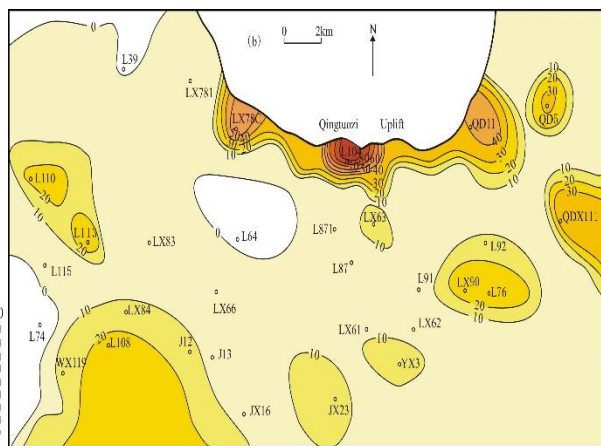
3816.2m, sand grain bedding, lenticular bedding



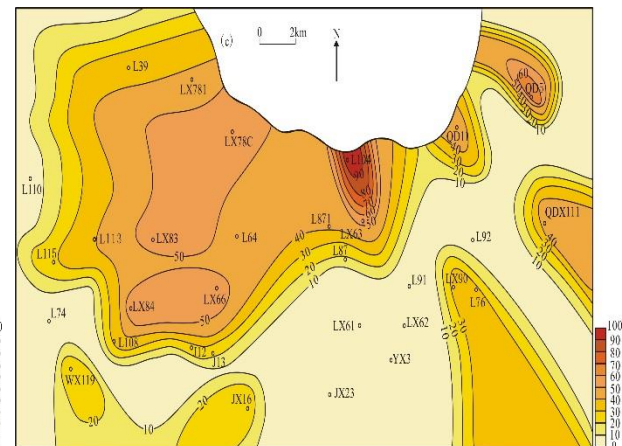
3817.5m, plant roots fossil



(a) LST

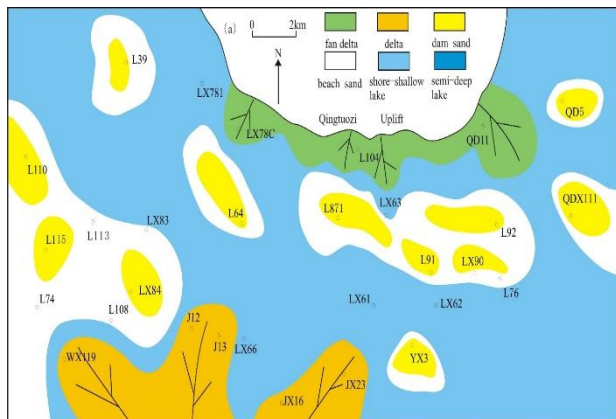


(b) TST

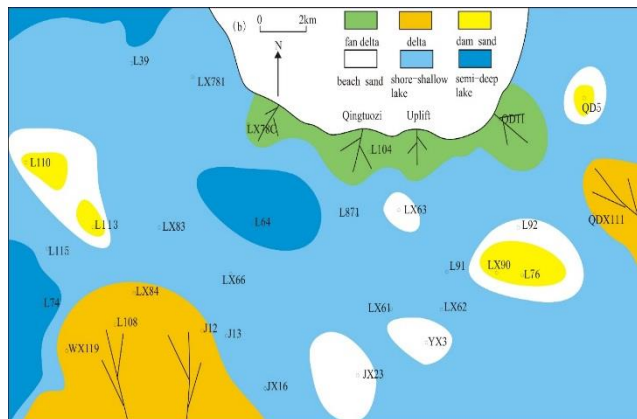


(c) HST

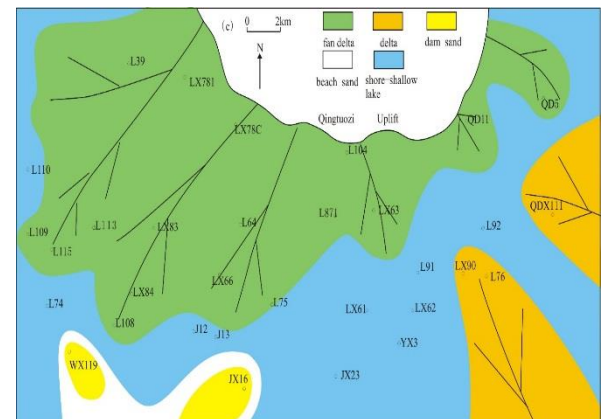
Glutenite percentage of the upper Es<sup>4</sup> in Qingnan Sub-Sag



(a) LST



(b) TST

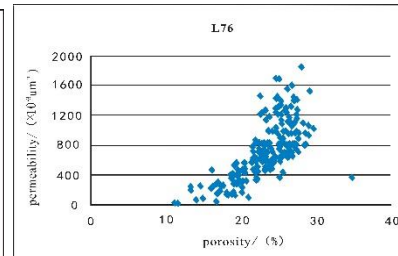
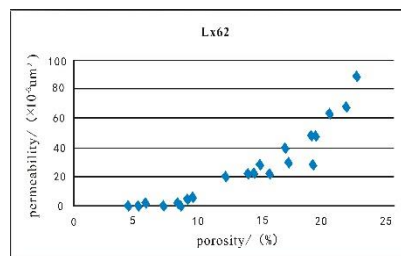
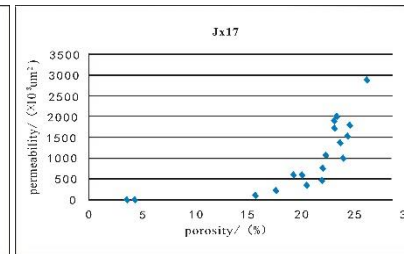
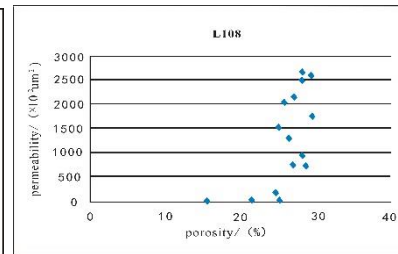
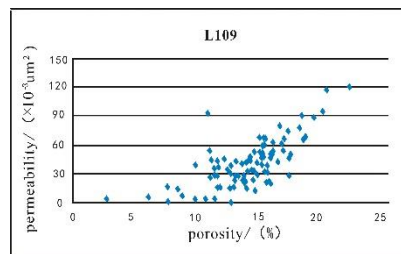
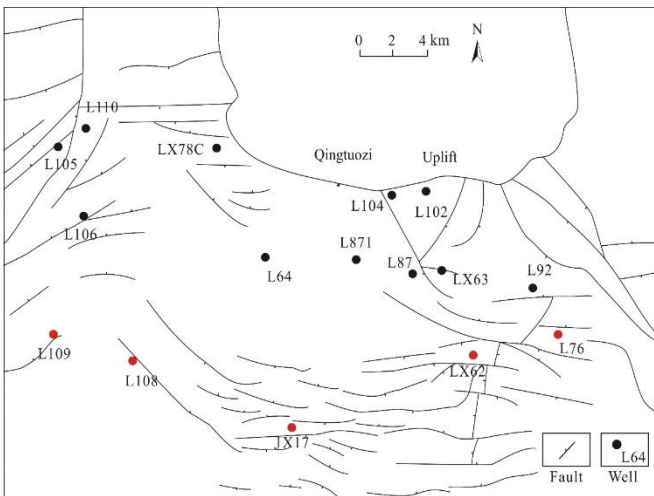
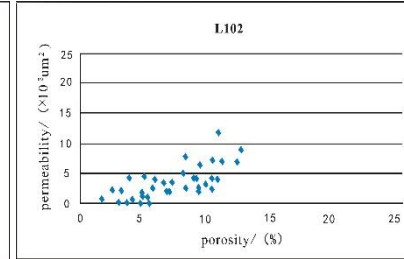
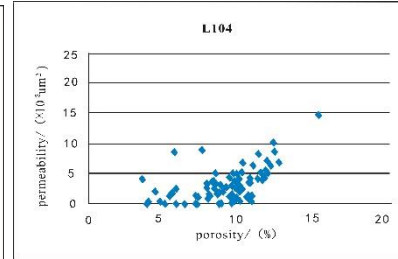
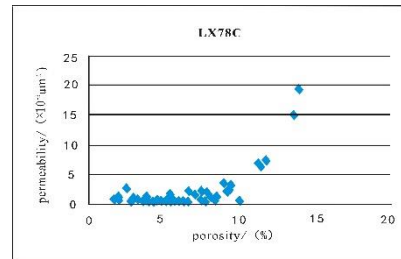
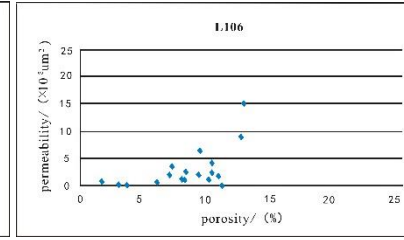
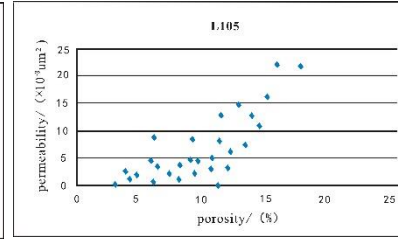
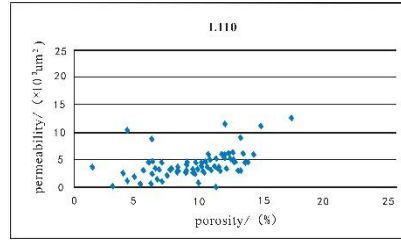
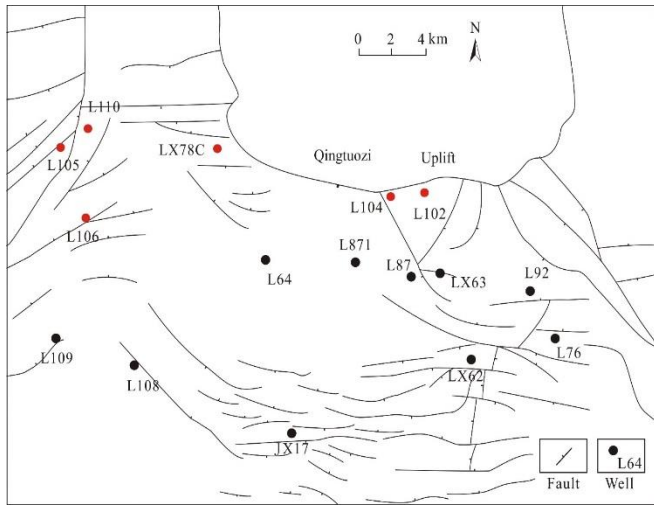


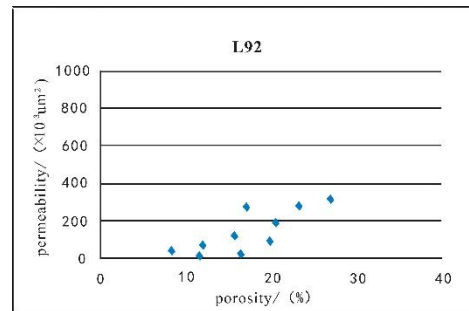
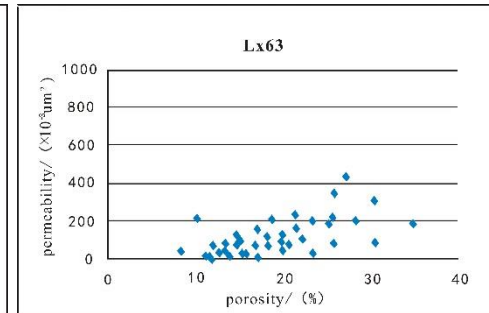
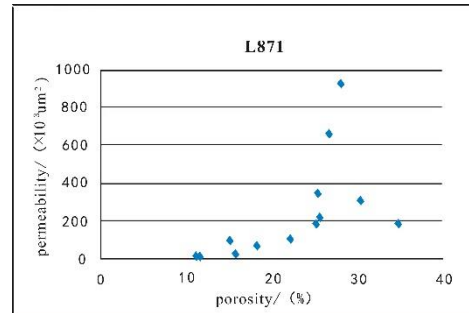
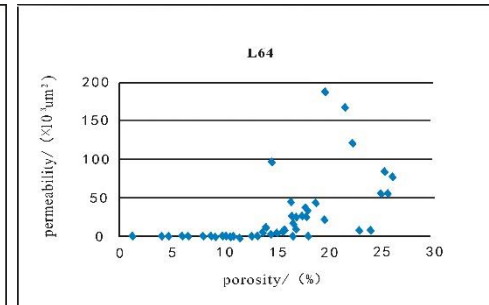
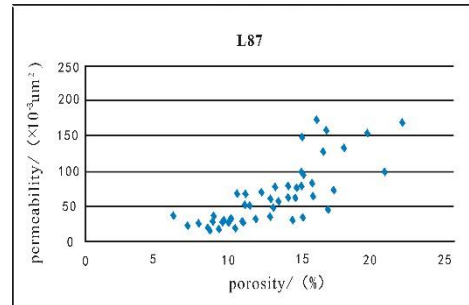
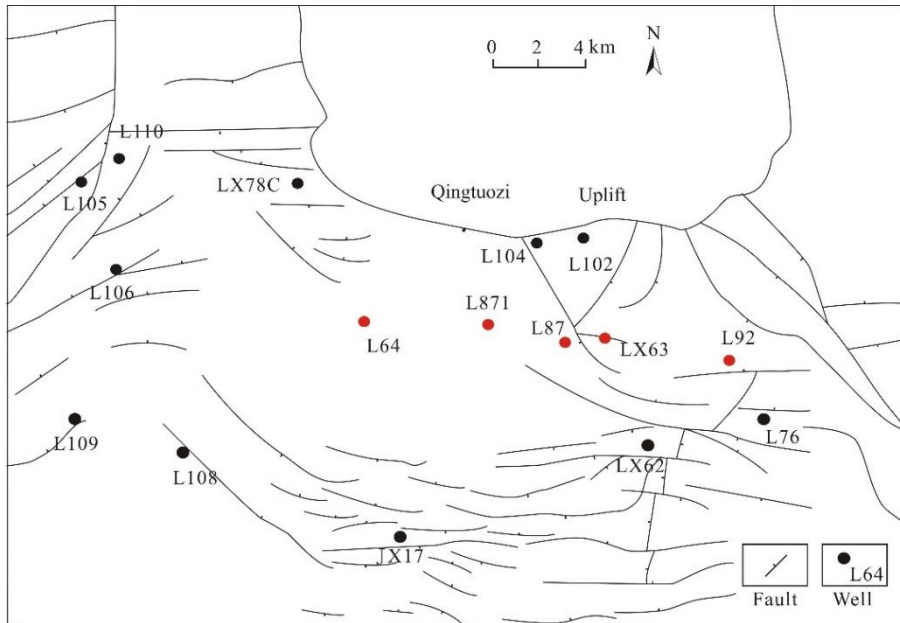
(c) HST

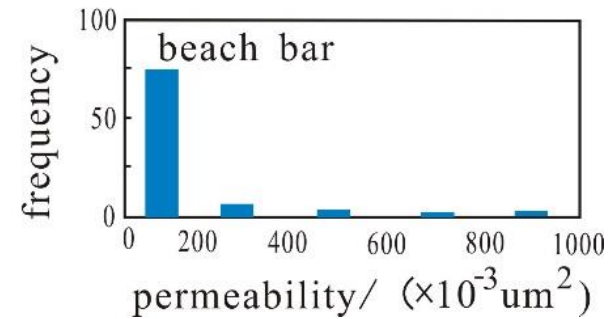
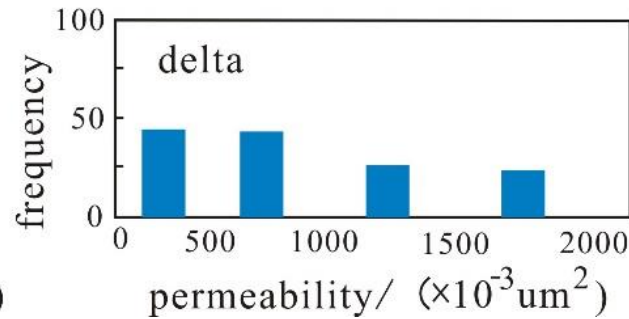
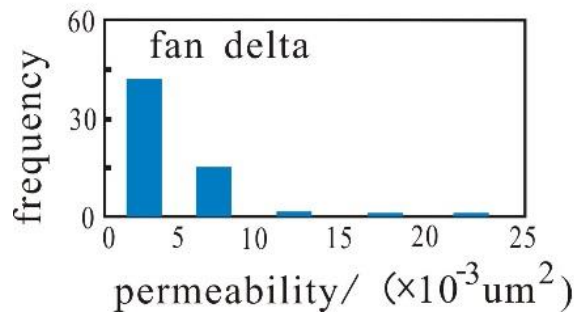
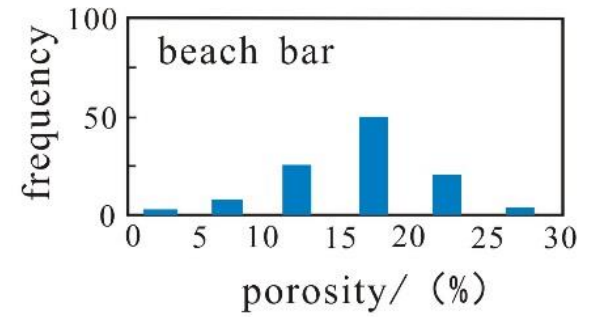
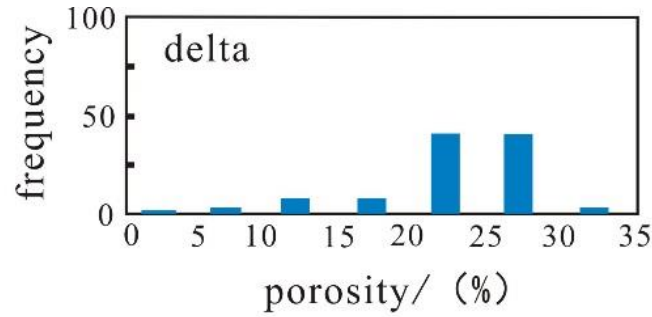
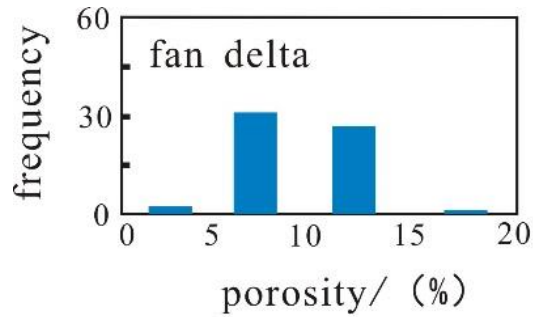
Distribution of depositional systems of the upper Es<sup>4</sup> in Qingnan Sub-Sag



### 3、The characteristics of reservoir in Qingnan subsag

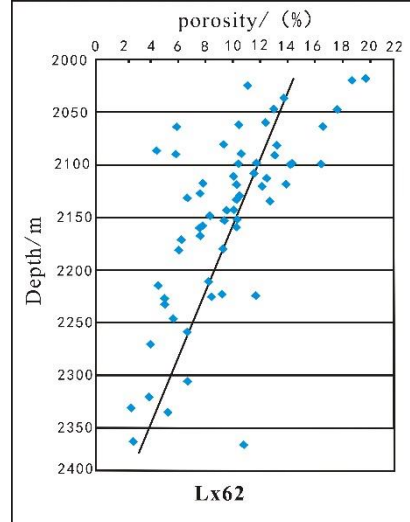
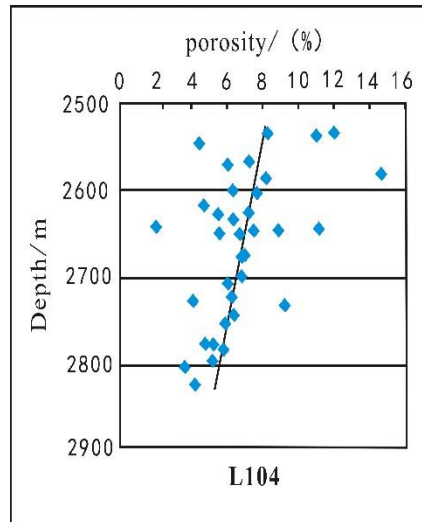
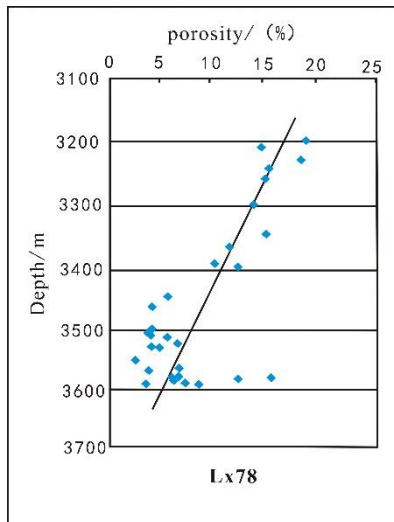
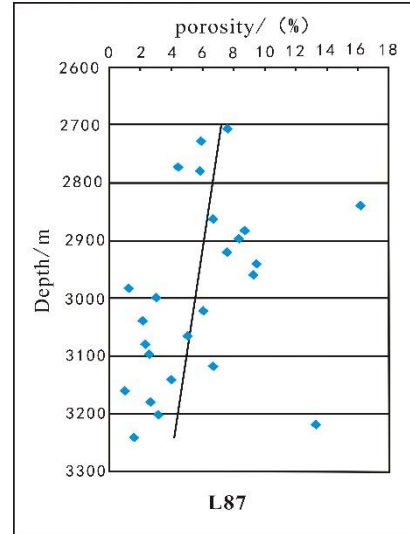
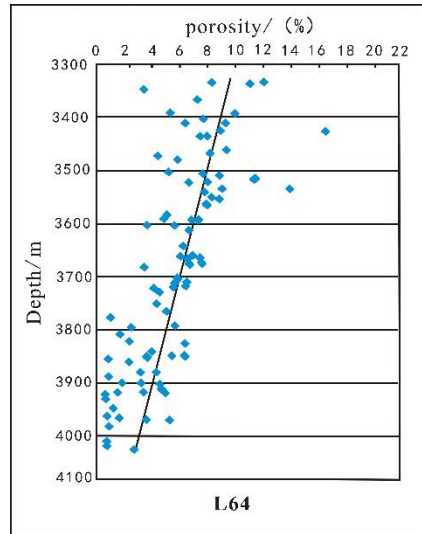
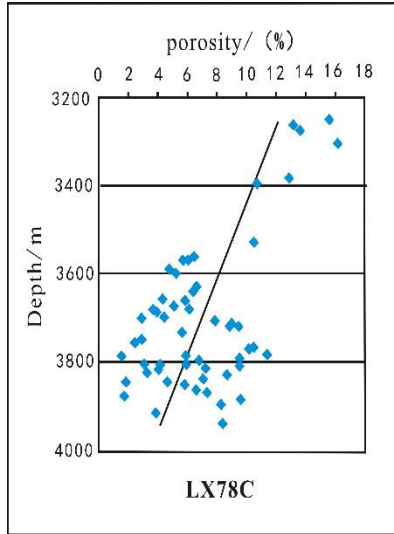






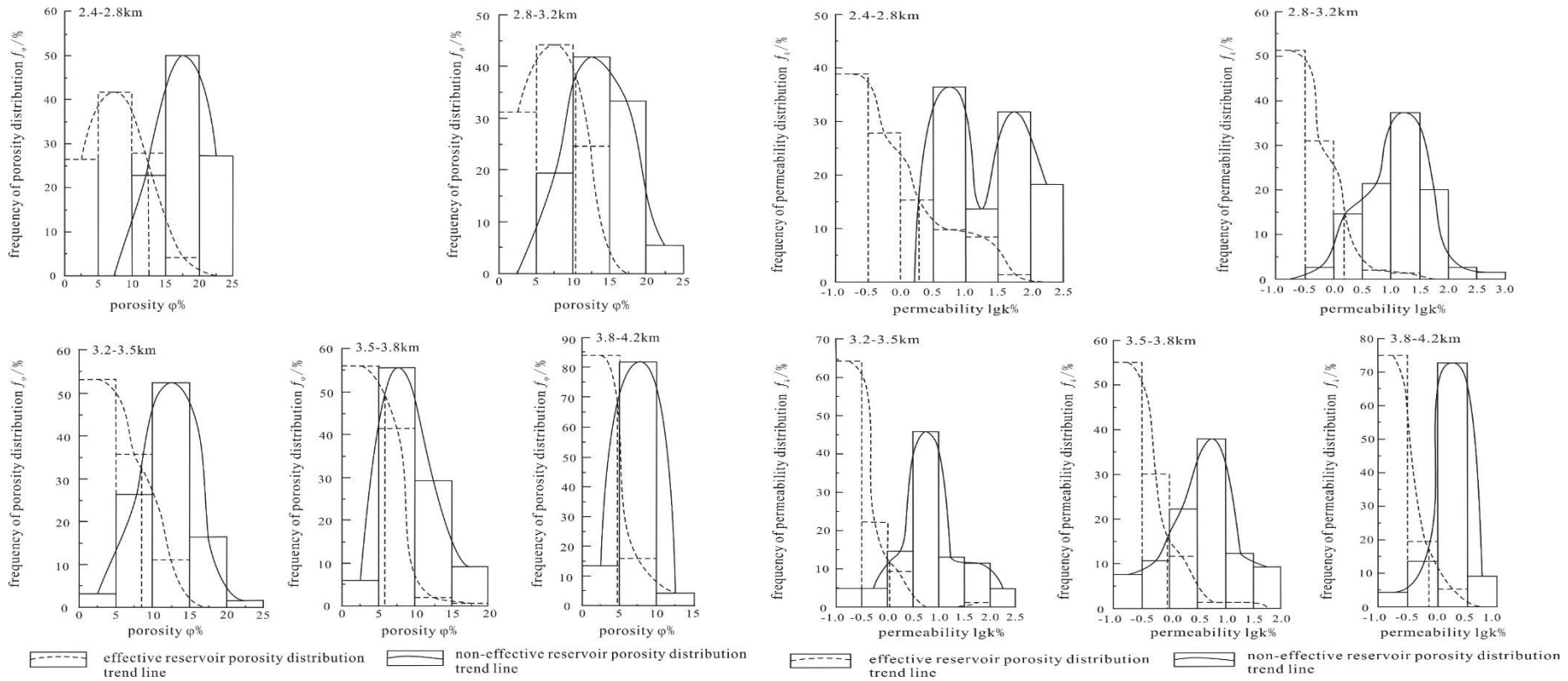
frequency histogram different sedimentary facies reservoir property distribution

The delta has the best physical property, followed by beach bar, the fan delta has the worst physical property in comparison



Along with the depth increasing, the reservoir physical properties are obviously decreasing

reservoir physical properties change with depth



### The lower limit of porosity

### The lower limit of permeability

Distribution function curve method is used to calculate the physical property lower limit of 2400~2800m、2800~3200m、3200~3500m、3500~3800m、3800~4200m.

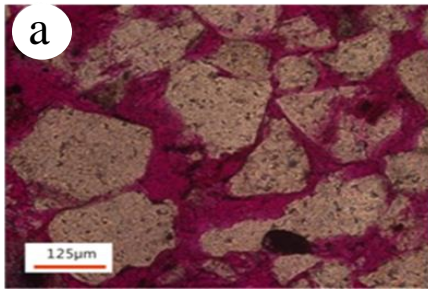
The lower limit of porosities are 12.5%、10.46%、8.5%、6.21%、4.95%

The lower limit of permeabilities are  $1.77 \times 10^{-3} \mu\text{m}^2$ 、 $1.58 \times 10^{-3} \mu\text{m}^2$ 、 $1.25 \times 10^{-3} \mu\text{m}^2$ 、 $0.93 \times 10^{-3} \mu\text{m}^2$ 、 $0.72 \times 10^{-3} \mu\text{m}^2$

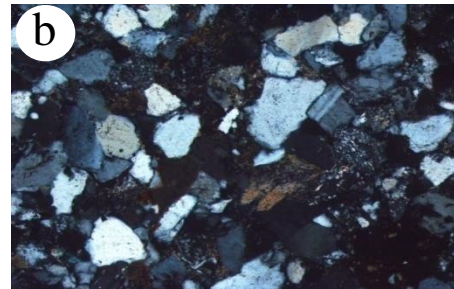




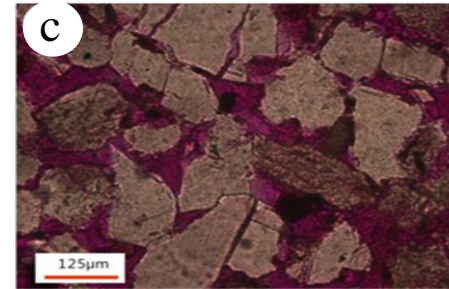
## Reservoir space types



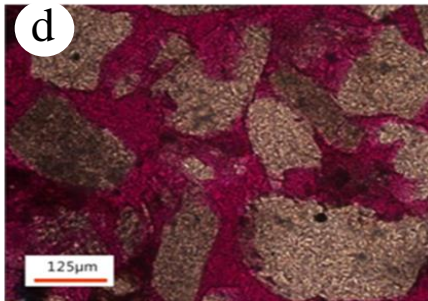
L105, 2769.5m, intergranular hole



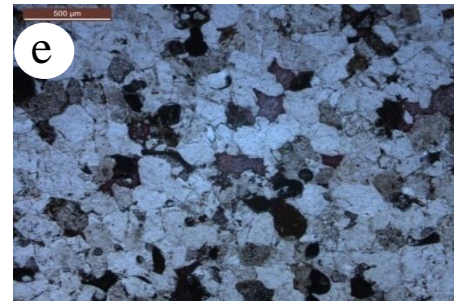
L87,3171.89 m, intergranular hole



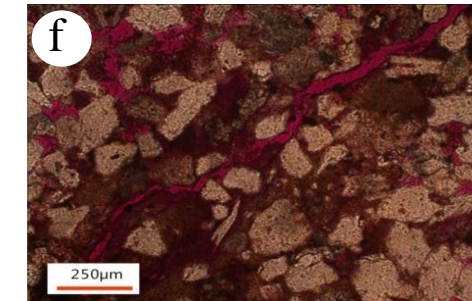
L104, 2311.6m, Secondary porosity, Feldspar particles formed intergranular pore



LX63,2385.5m, Secondary porosity, dissolved hole of quartz and feldspar

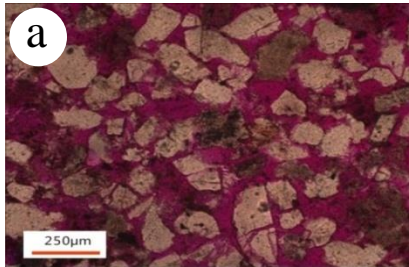


L64,3815.2m, Secondary porosity, dissolved hole of quartz and feldspar

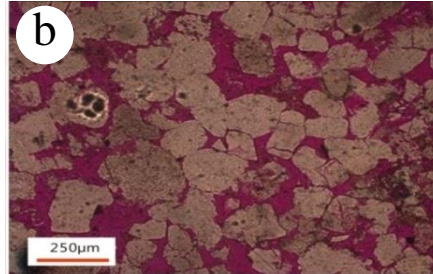


L111,2468.1m, a few cracks

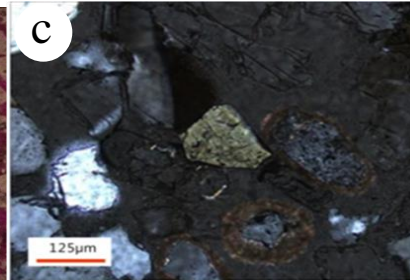
## Diagenesis types



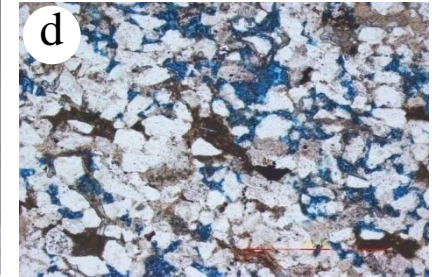
LX62-1,2311.6m, porous cementation, point contact



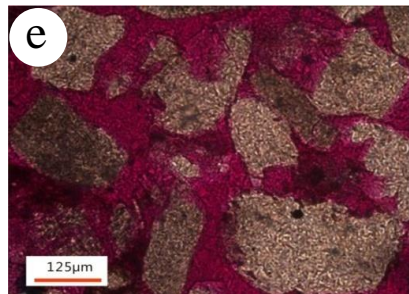
LX62-1,2305.7m, porous cementation, point-line contact



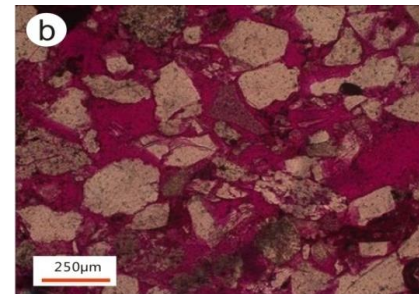
L108,2481m, Sparry calcite around a single quartz and feldspar, Concentric rings



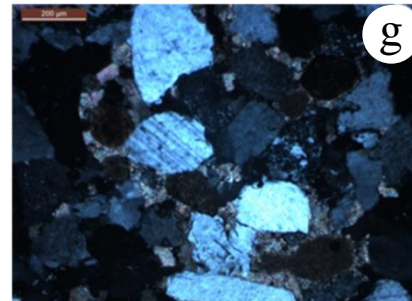
L87,3164.95m, Iron calcite cementation, Quartz overgrowth



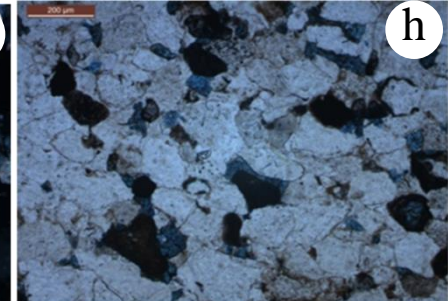
LX63,2385.5m, quartz dissolved



L105,2769.5m, feldspar dissolved

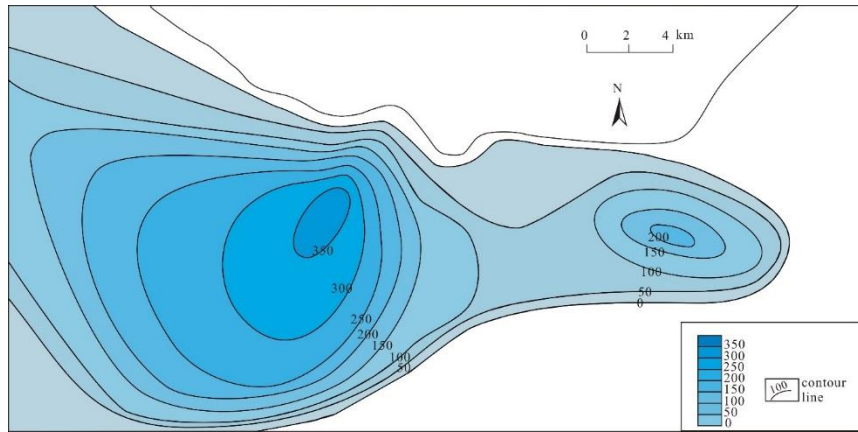


L64-1,3813.67m, Quartz overgrowth, porous cementation, line contact



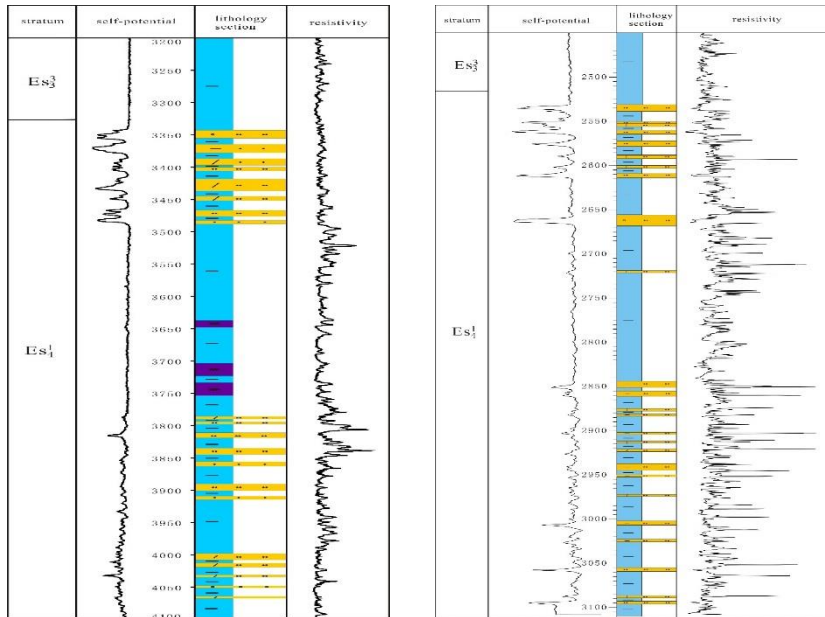
L64-2,3814.35m, line contact

## 4、 Analysis of the relationship of sedimentary and reservoir with oil and gas accumulation



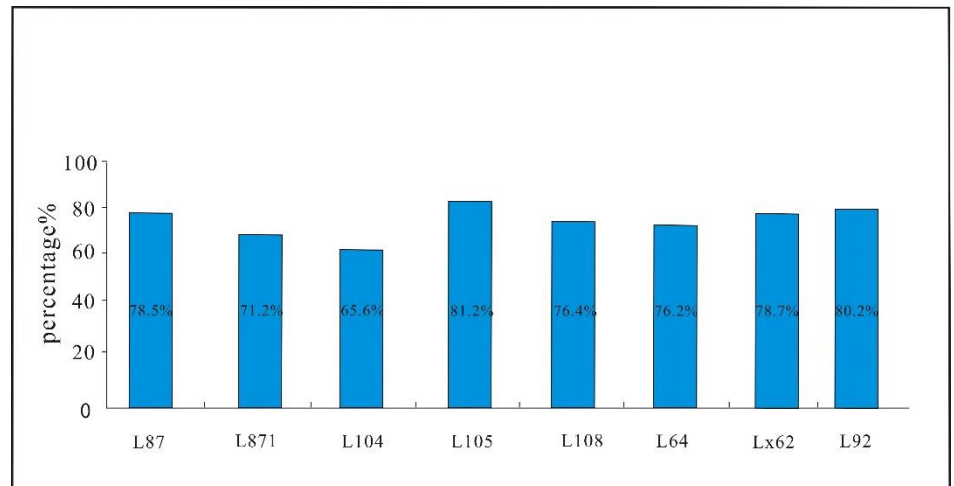
Thickness of hydrocarbon source rocks

**Thickness of hydrocarbon source rocks :**  
maximum 350m  
**reservoir :** Physical property is good  
**cover coat :** Mud/sand ratio is mostly more than 70%, has the large thickness of single stratum and good continuity

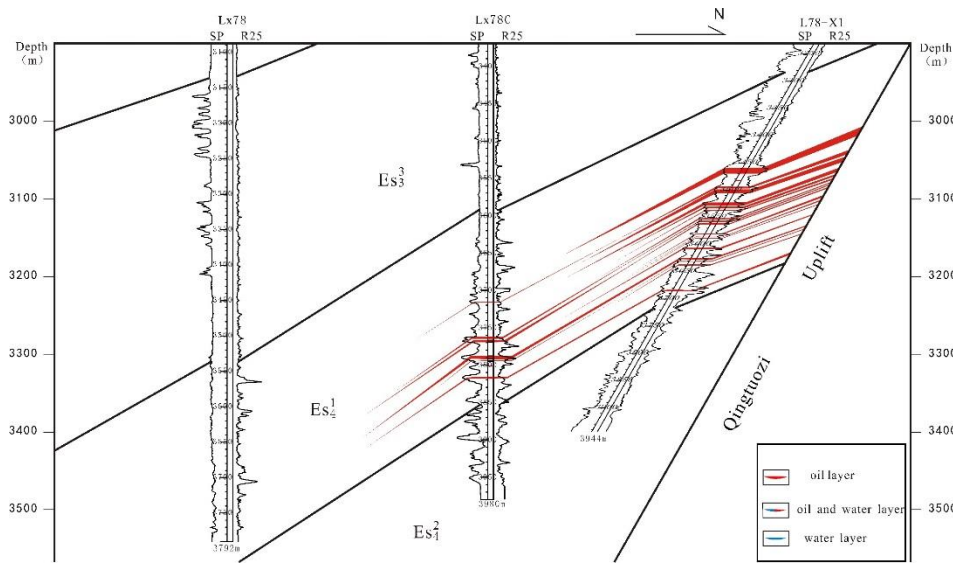


Well 64

Well 87

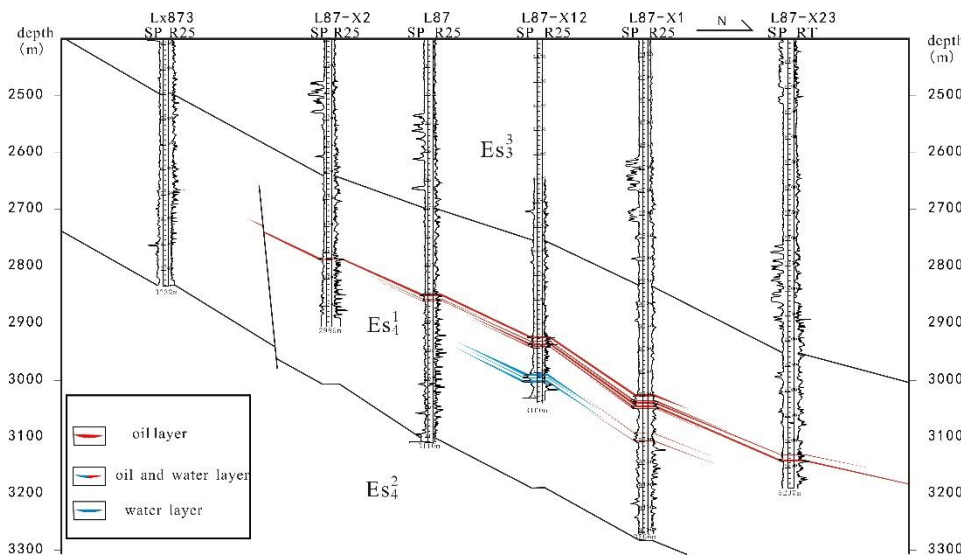


Mud/sand ratio of Qingnan sub-sag

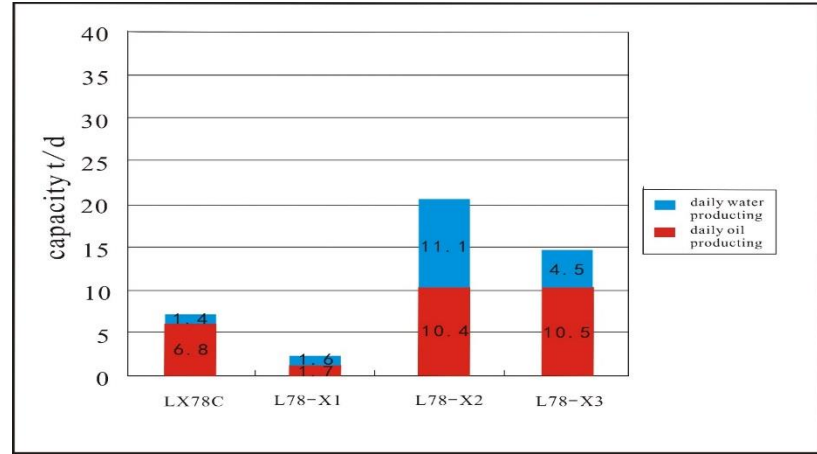
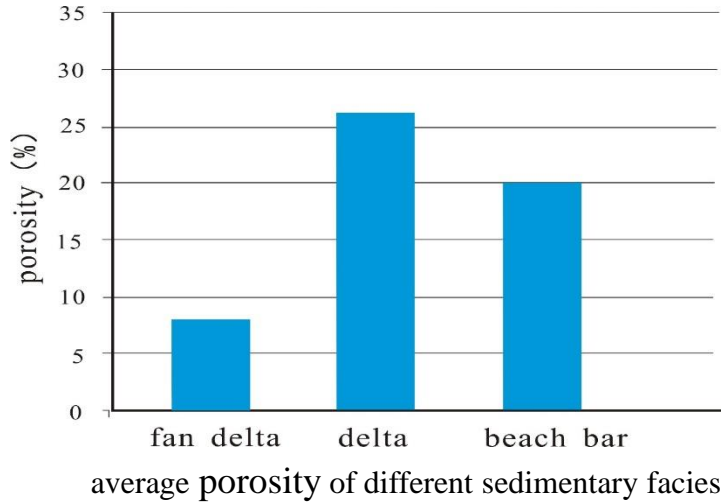


LX78-LX78C-L78-X1 north-south oil deposit profile

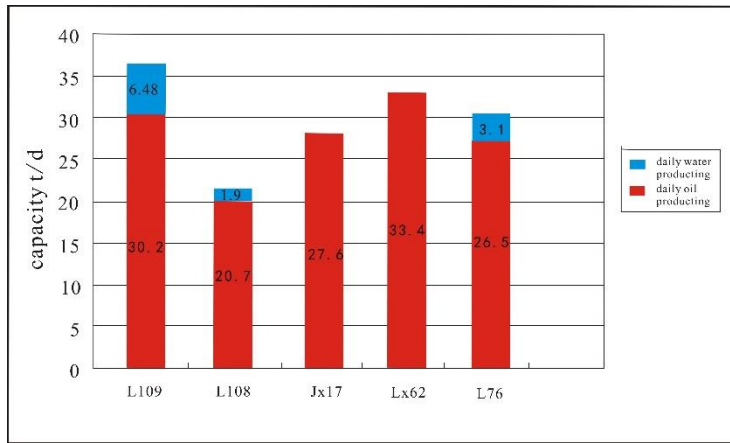
**main reservoir:** mainly beach bar sand body, part of fan delta sand body  
**main oil-bearing series:** all oil deposits are found in upper Es4 reservoir



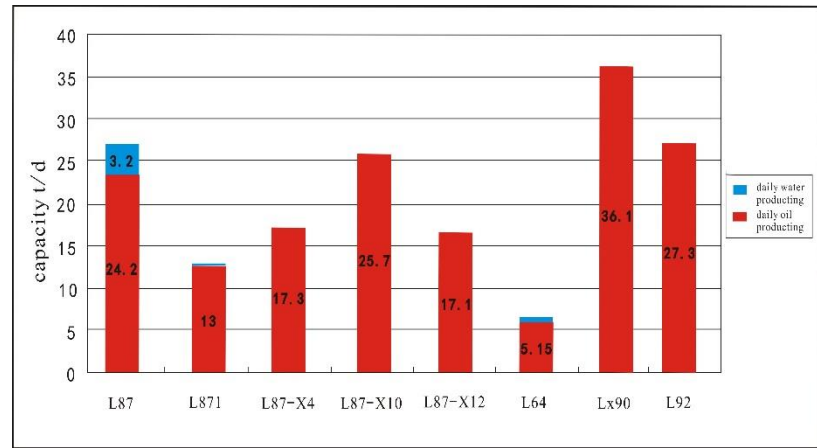
LX873-L87-L87-X23 north-south oil deposit profile



oil and gas production of fan delta reservoir



oil and gas production of delta reservoir  
oil and gas production of delta reservoir



oil and gas production of beach bar reservoir



## 5、 The conclusions and thoughts

- 1、 **Three** sedimentary facies are identified in Qingnan sub-sag, including fan delta facies、 delta facies and beach bar facies.
- 2、 Delta sand body is **medium-high** porosity and **high** permeability reservoir; the beach bar sand body is **medium** porosity and **medium** permeability reservoir; the fan delta sand body is **very low** porosity and **very low** permeability reservoir. The reservoir property reduce as the depth increase.
- 3、 Reservoir space types include primary pore, secondary pore and fracture, and mainly in primary pore. Beach bar sand diagenesis mainly includes **compaction**, **cementation**, **dissolution** and **metasomatism**
- 4、 Qingnan sub-sag has good reservoir and caprock, the mainly reservoir is beach bar sand body and part of fan delta sand body. The reservoir physical property determines capacity of oil and gas , oil and gas productivity of delta reservoir is the highest, followed by beach bar reservoir, the fan delta reservoir is the lowest.



Thanks for your attention !

Looking for your suggestion!

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