

The Geomodeling of Fan-delta Reservoir with Clastics and Carbonate in Bohai Bay

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Reservoir Description Engineer
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What's Next?

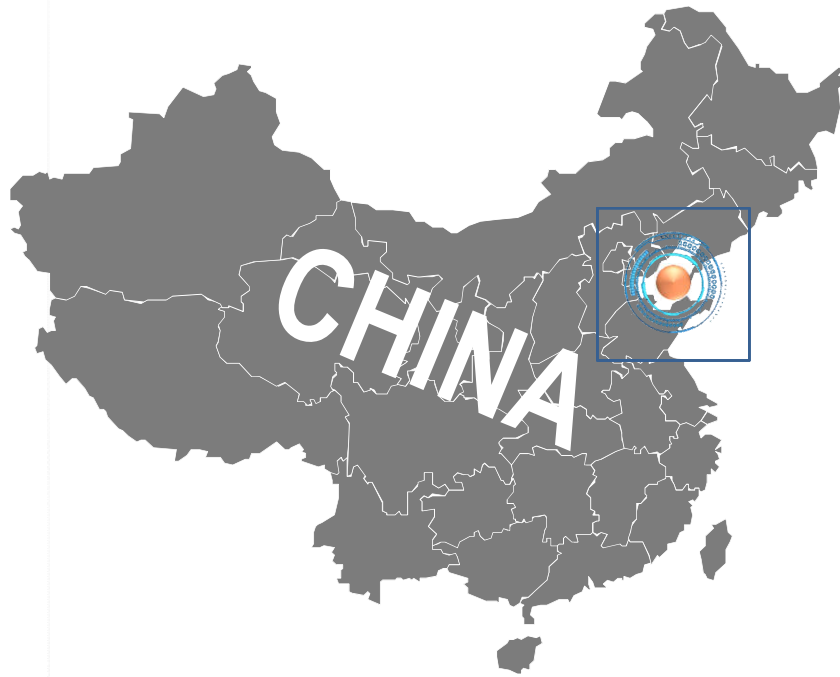
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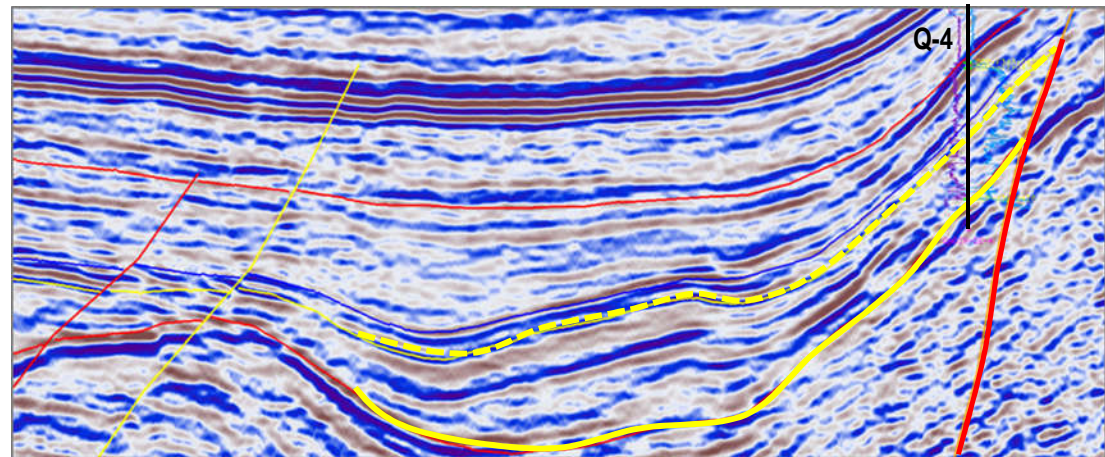
What`s Next



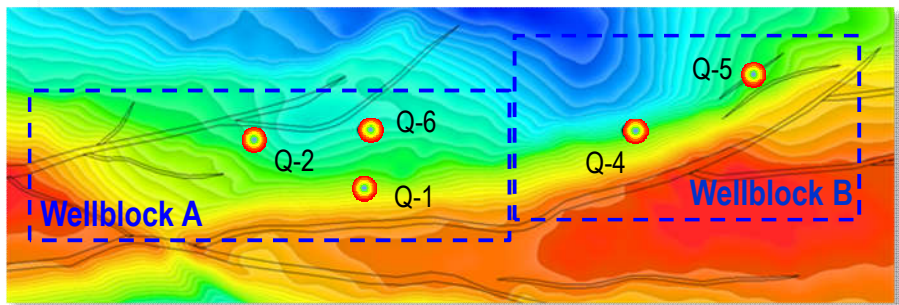
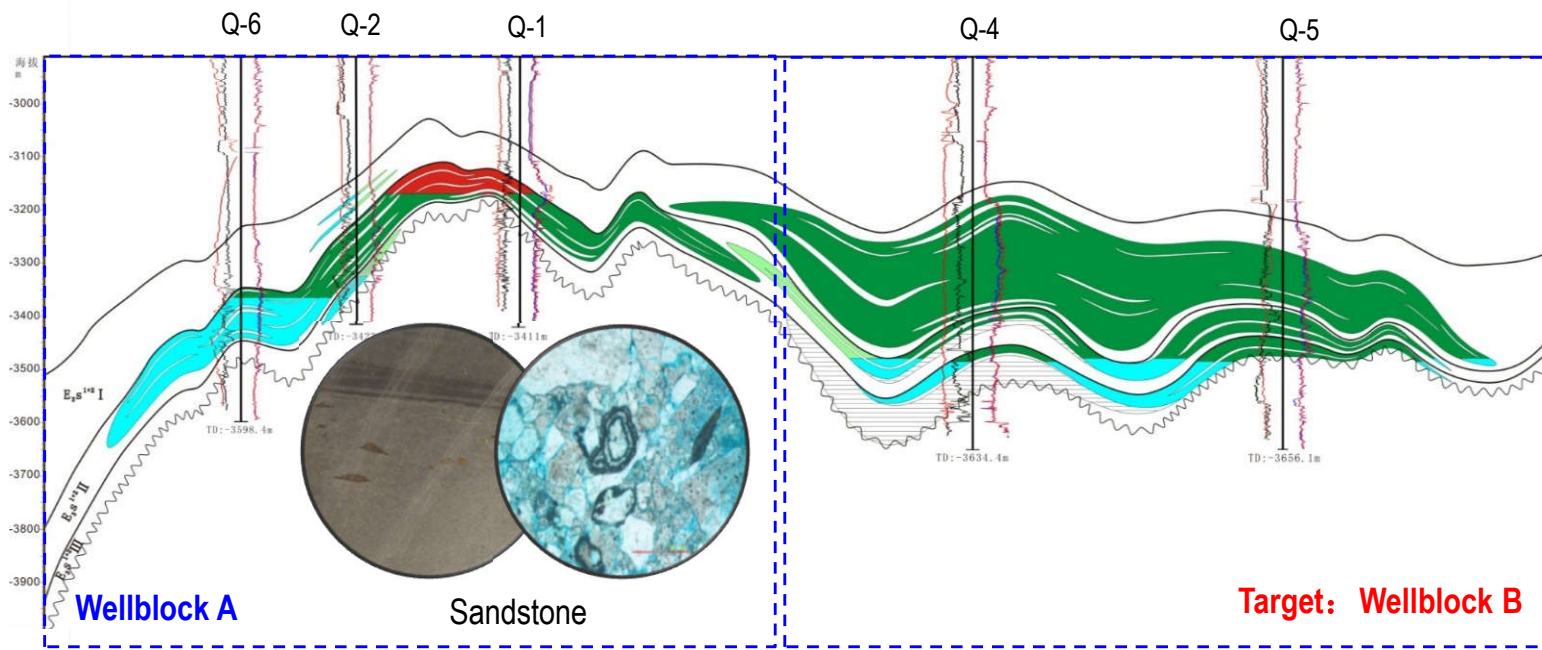
Paleogene is the next direction of petroleum exploration and development in China offshore



- The limited evaluation wells in offshore oil field
- Low quality seismic data
- Serious internal heterogeneity

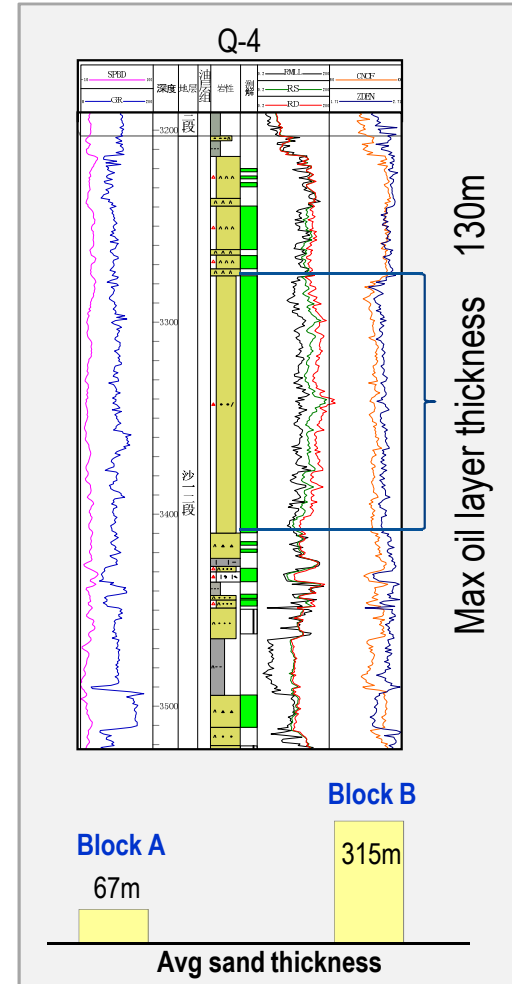
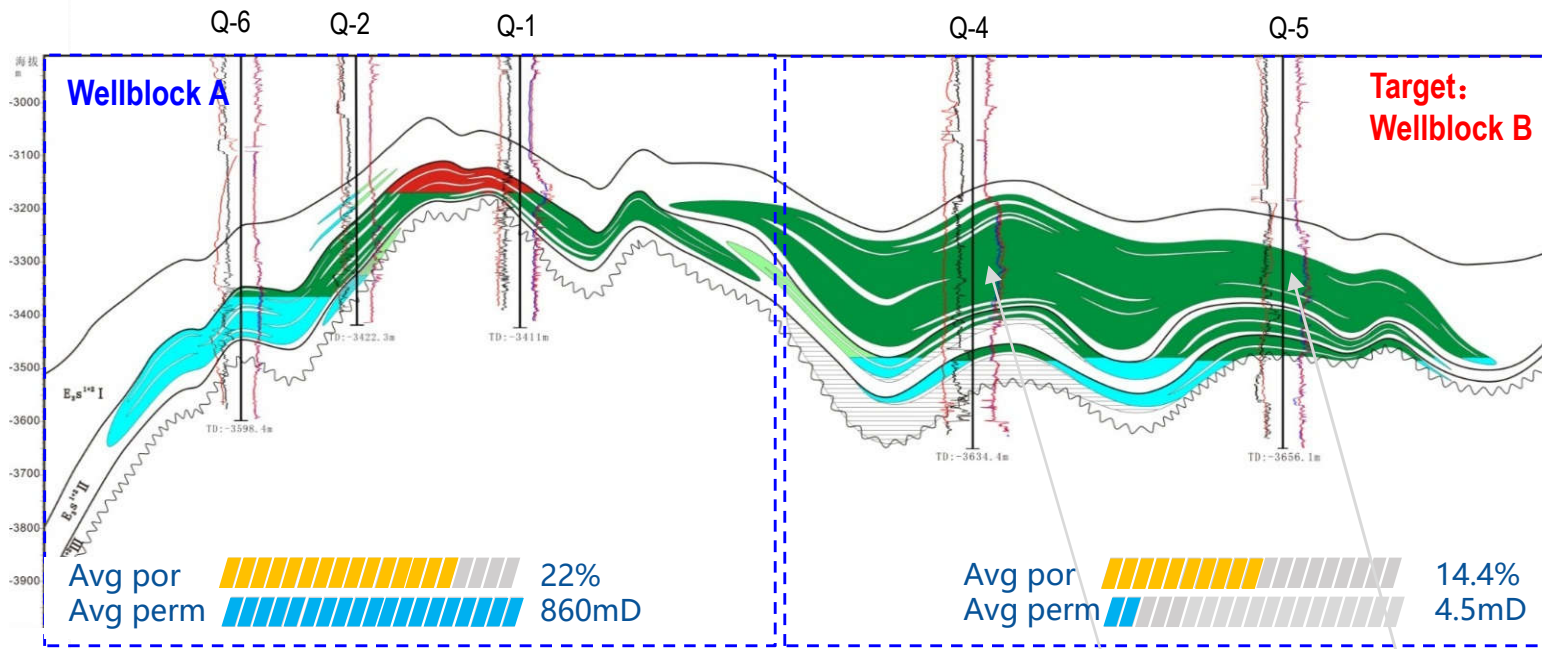


Research Challenge

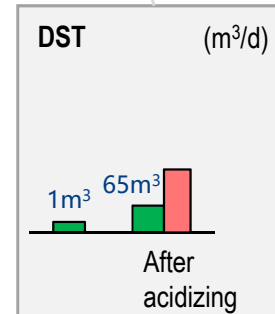
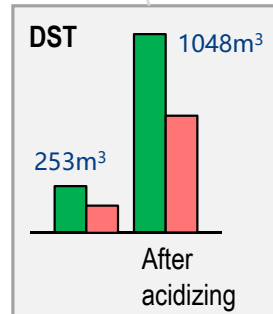


- Vertical complex lithology distribution because of the clastic and carbonate mixed deposition

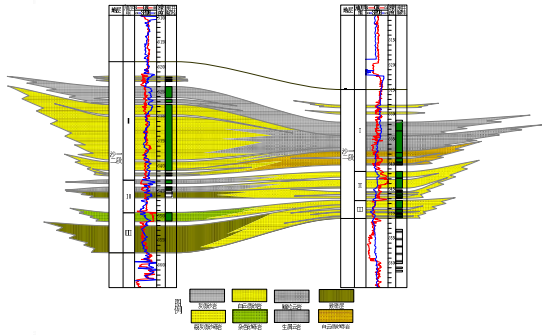
Research Challenge



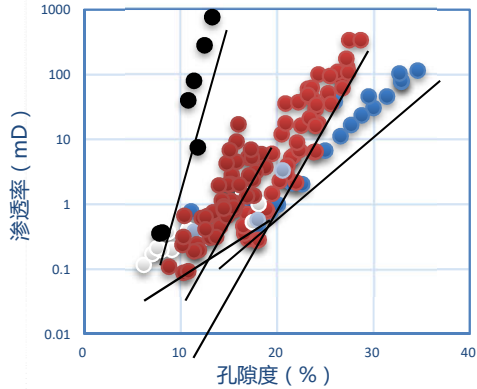
- Thickness of the reservoir is large but with quick lateral changes
- Low porosity and super-low permeability



Key technologies combination



Build stratigraphic framework combined lithology with seismic



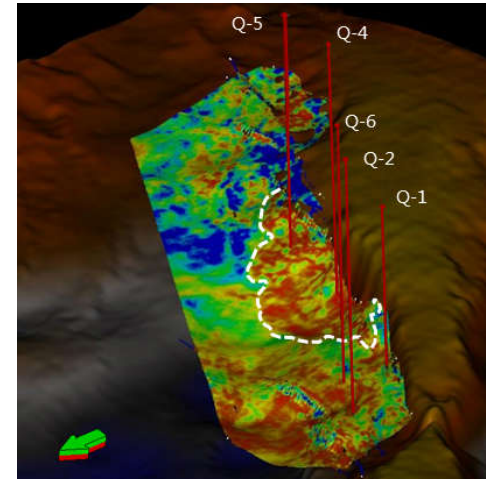
Constraint reservoir property distribution by lithology classification

1

2

3

Identify fan-delta sedimentary structure guided by seismic attribute



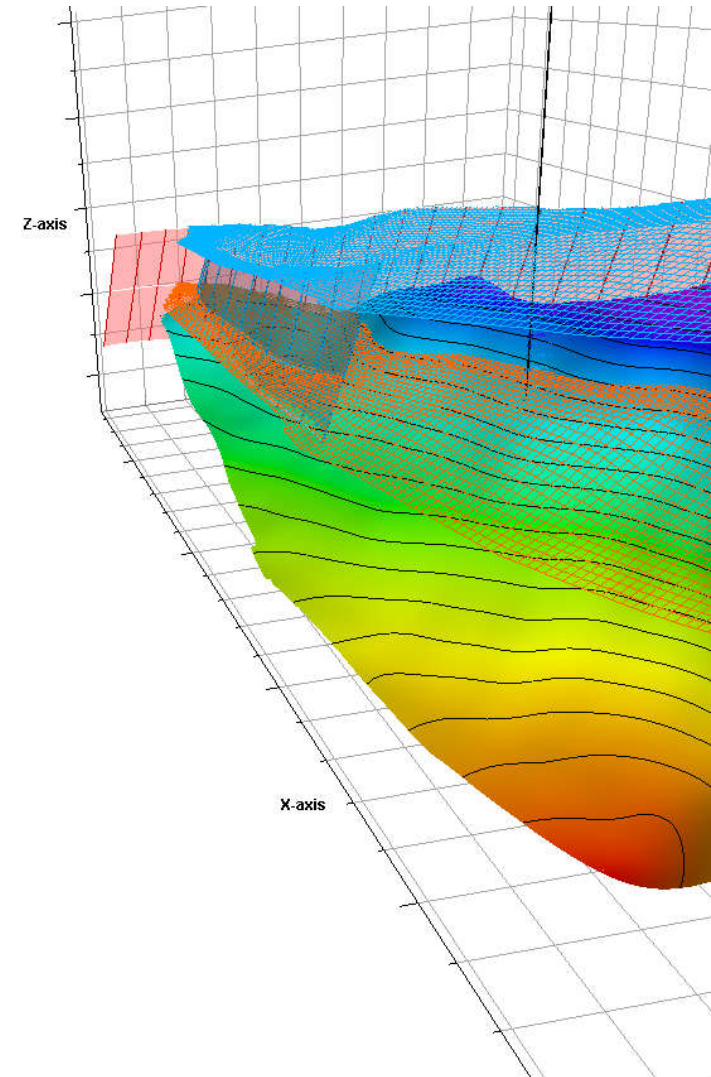
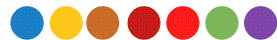
Build Digital Reservoir of Paleogene Fan Delta



1

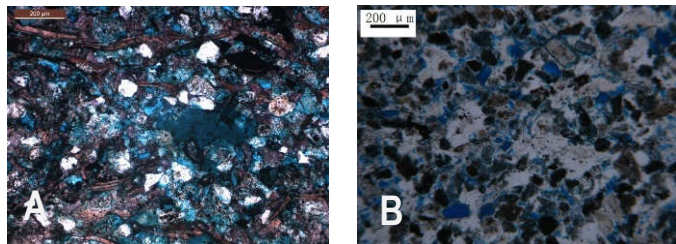
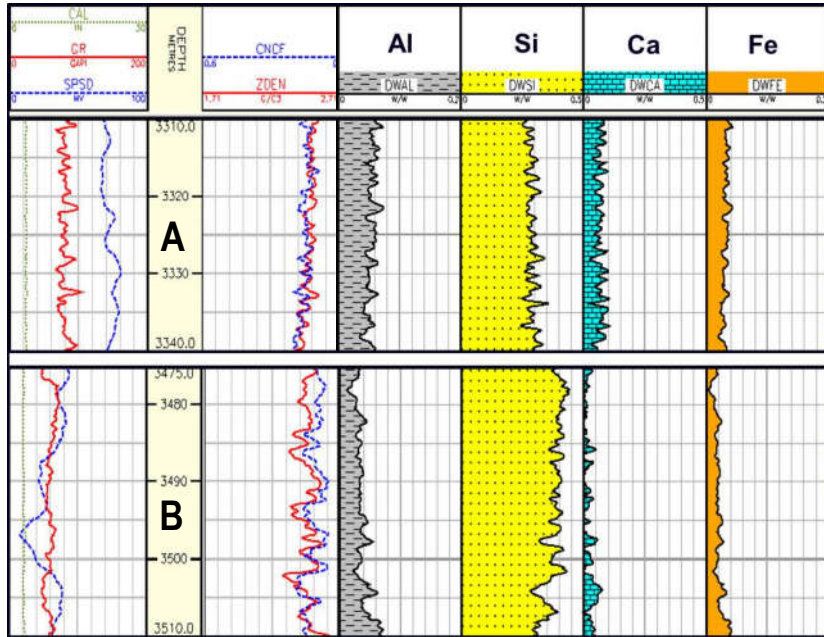
Build stratigraphic framework combined lithology with seismic

Build Digital Reservoir of Paleogene Fan Delta

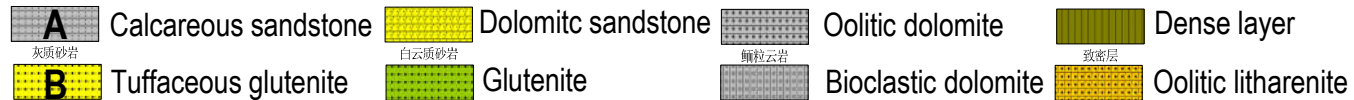
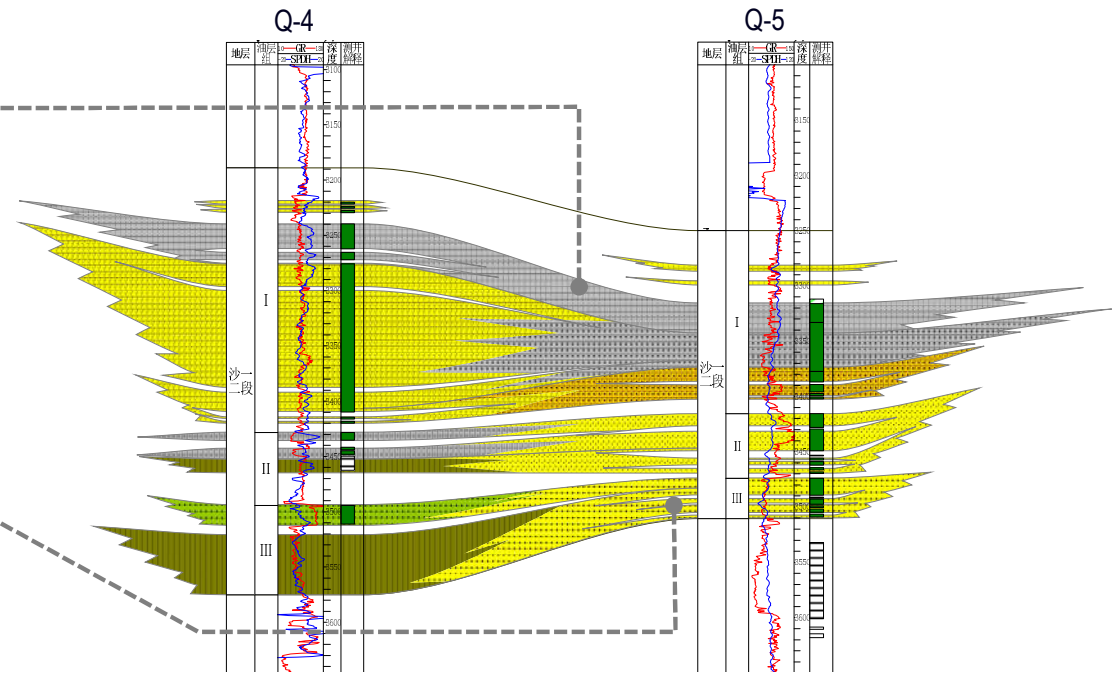


Identify complex reservoir lithology

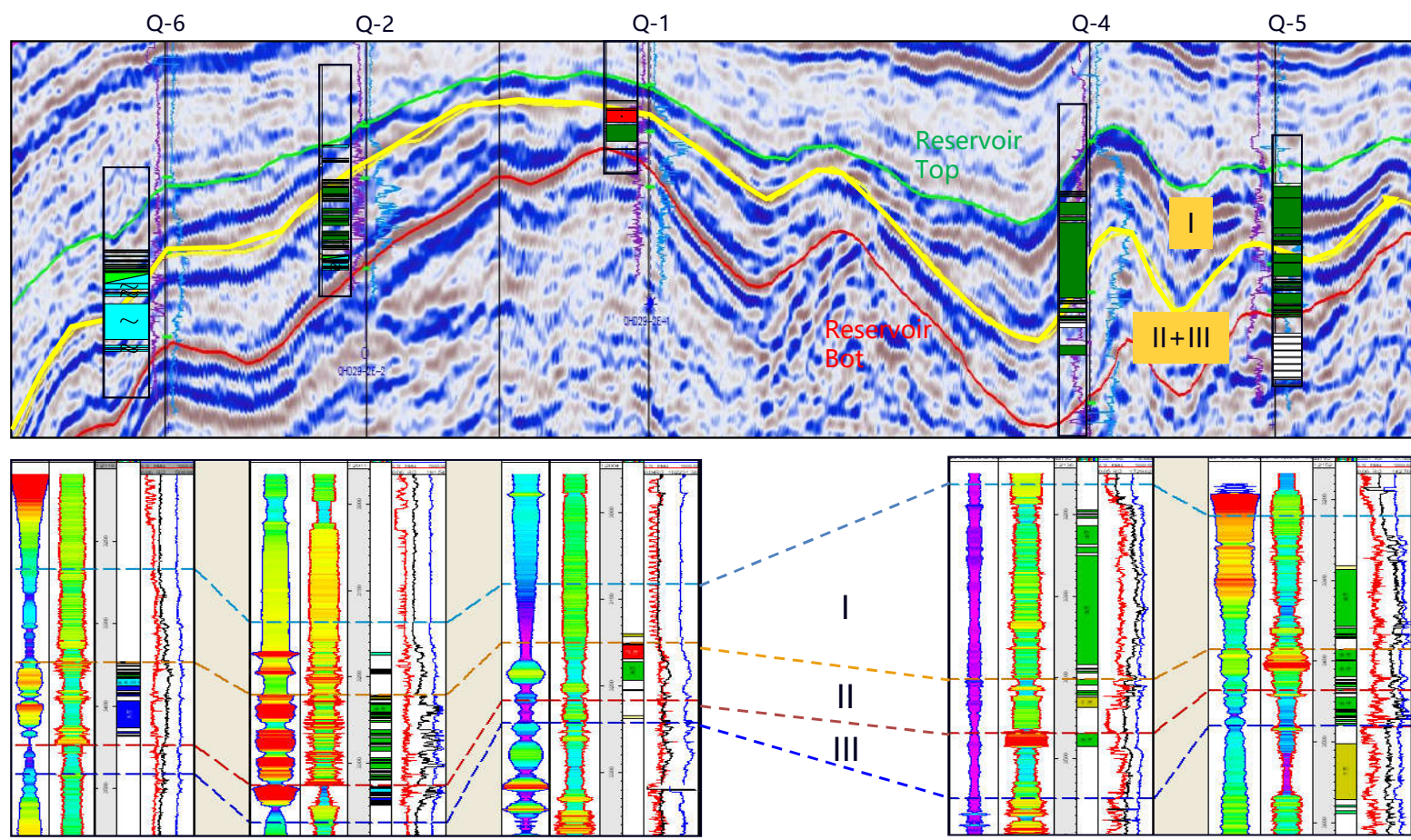
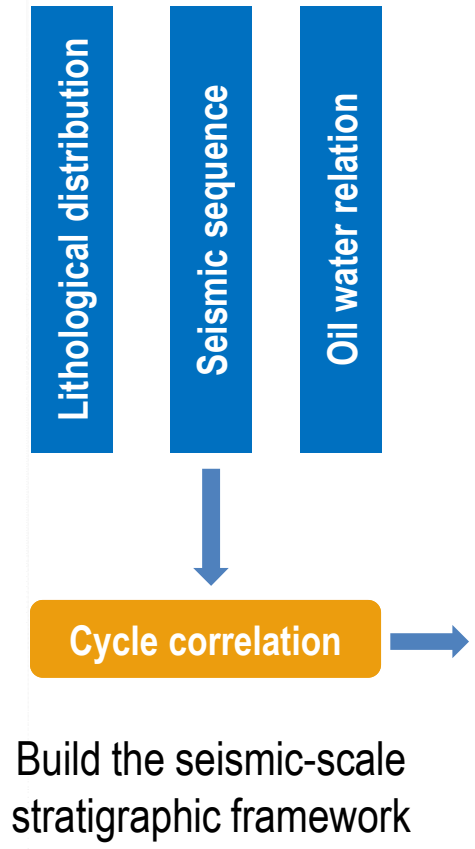
ECS logging response characteristics (Q-5)



- Judge lithology-mineral assemblage by ECS (element capture spectroscopy) macroscopically
- Identify rock type combined with cores and thin sections microscopically



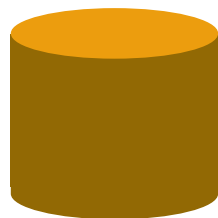
Build stratigraphic framework



Build stratigraphic framework



Seismic attribute slice analysis

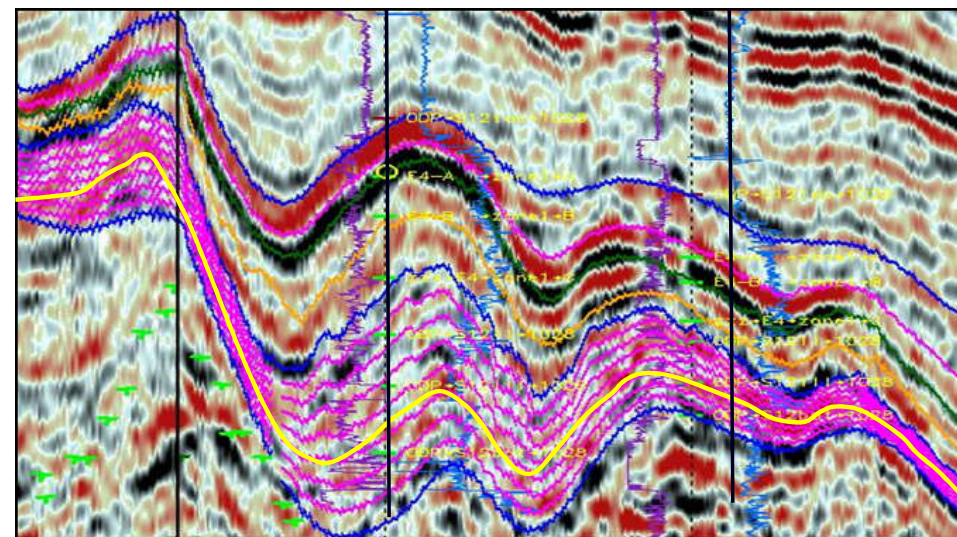
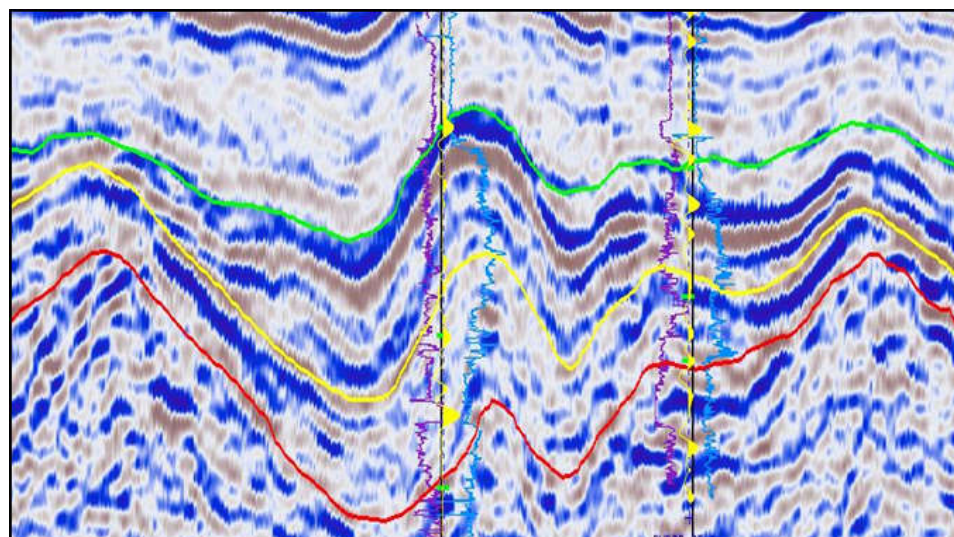


Q-4

Q-5

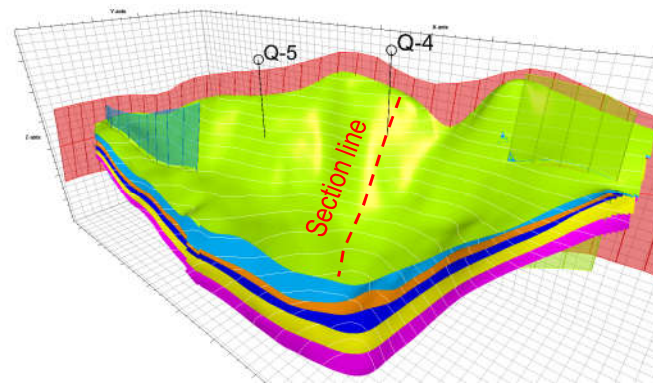
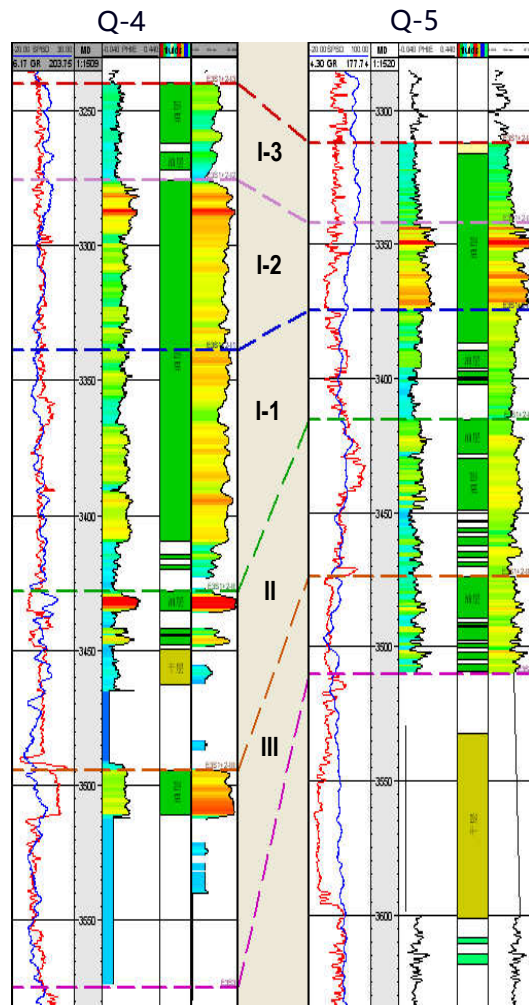
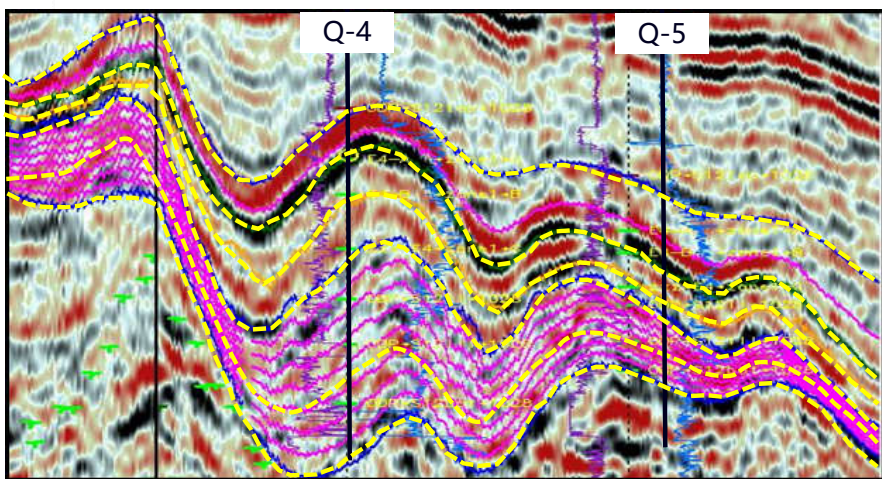
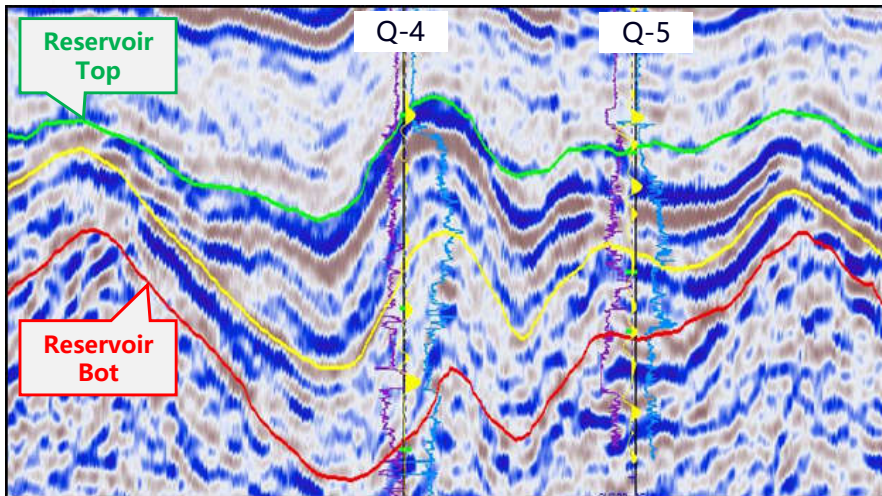
Q-4

Q-5

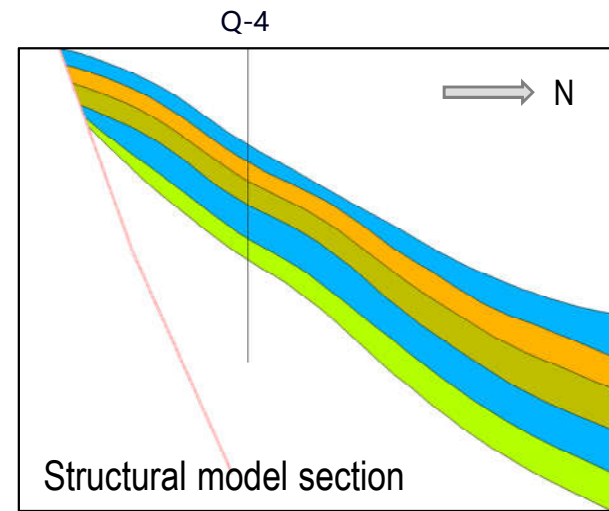


Subdivide formation by seismic attribute slice analysis to build the fine stratigraphic framework

Build structural model



Structural model



Structural model section



2

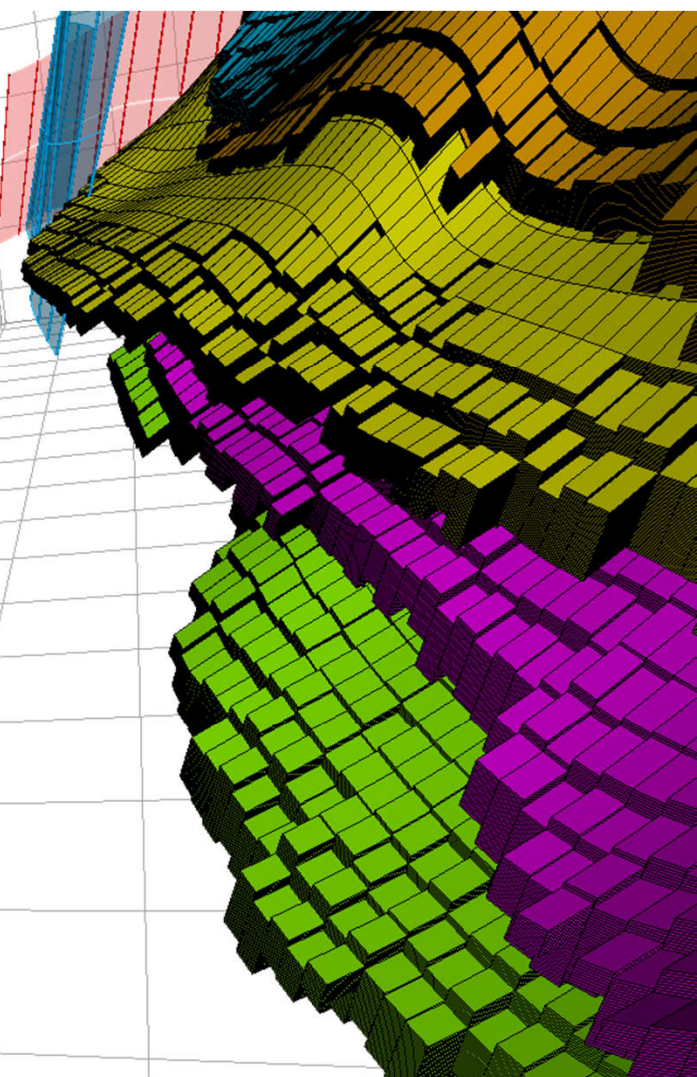
Identify fan-delta sedimentary structure guided by seismic attribute

Build Digital Reservoir of Paleogene Fan Delta

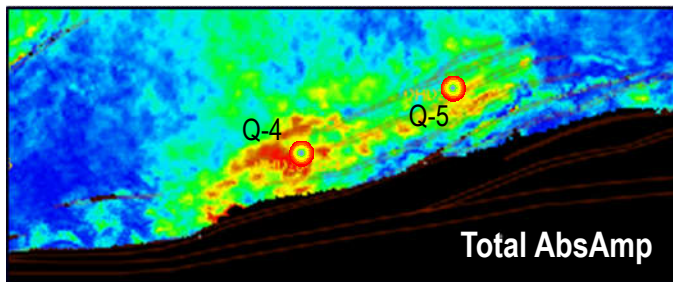
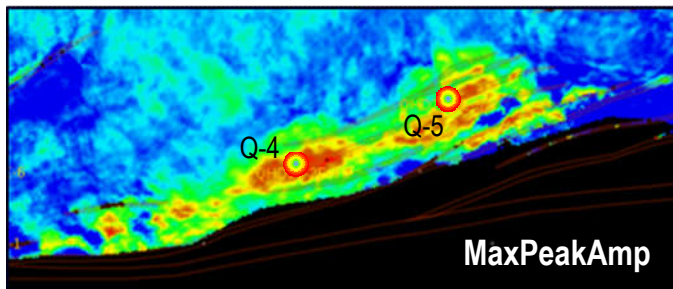
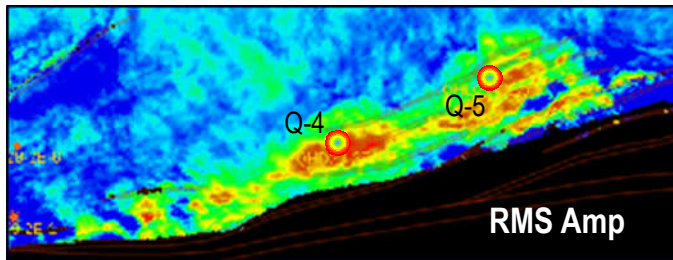


X-axis

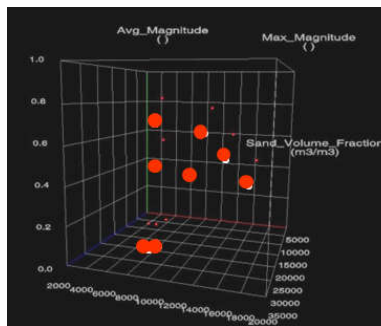
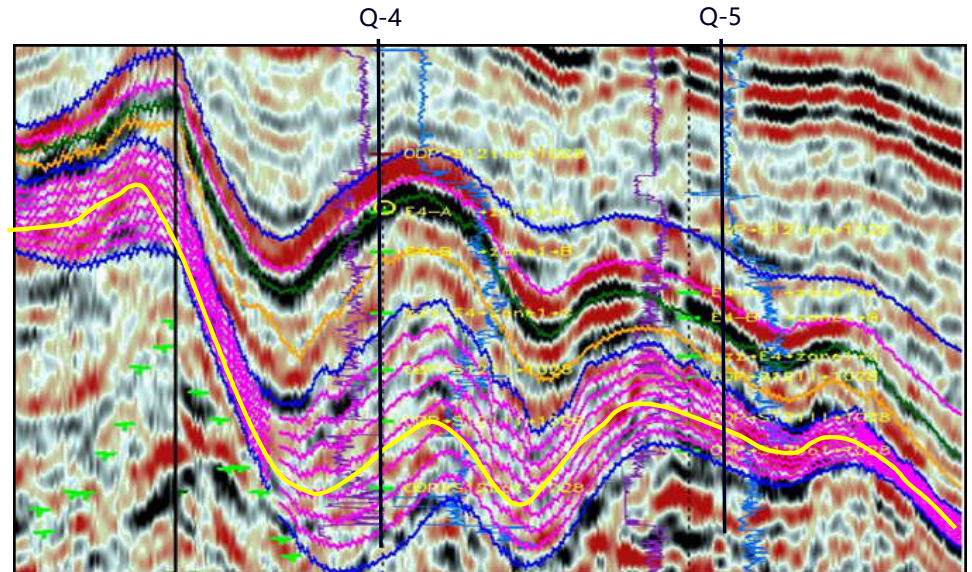
Z-axis



Predict fan-delta distribution

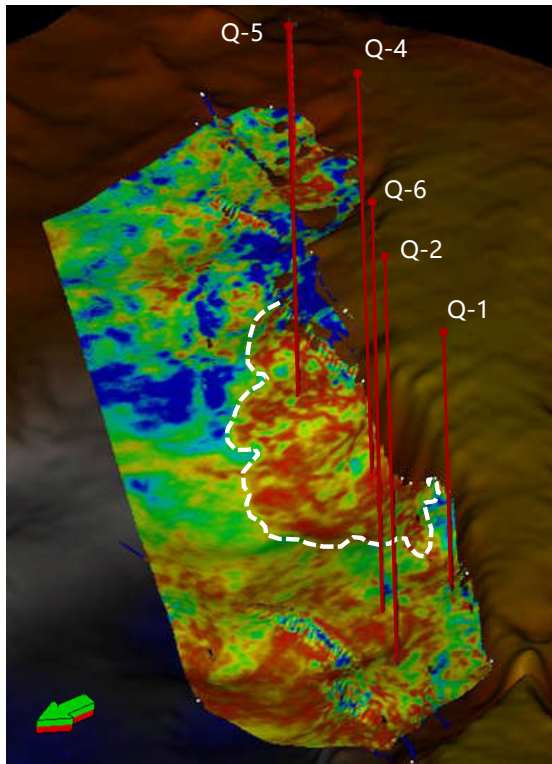


Seismic multi-attribute analysis

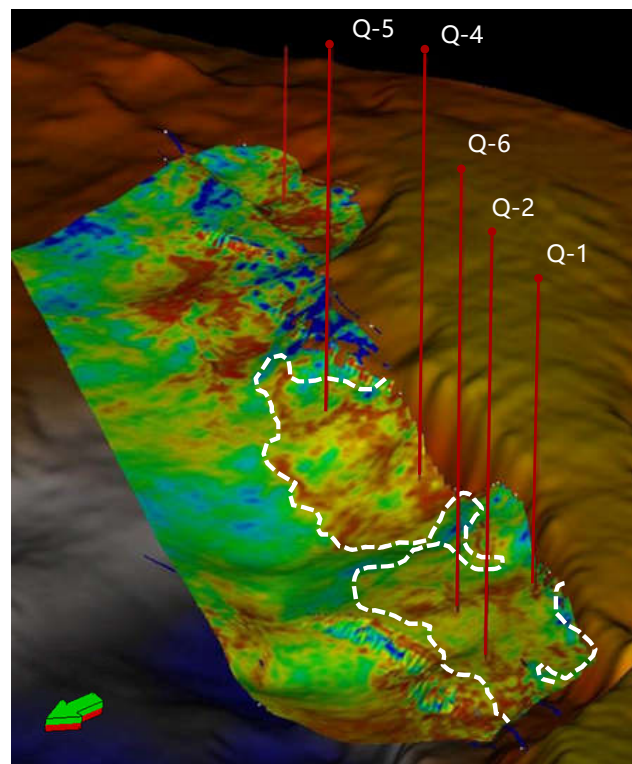


Sensibility analysis of seismic attributes

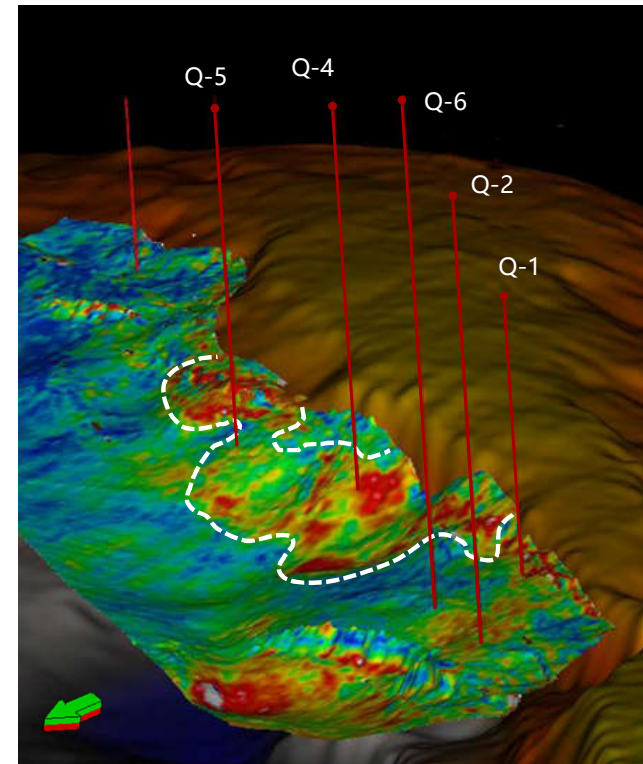
Predict fan-delta distribution



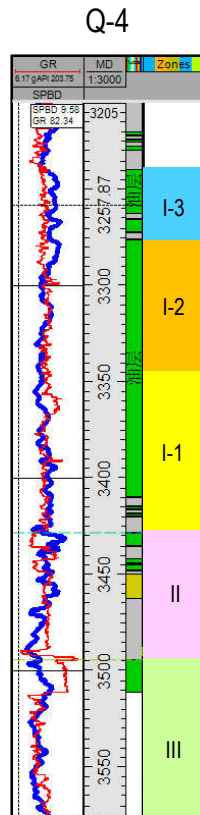
Seismic attributes slice (III)



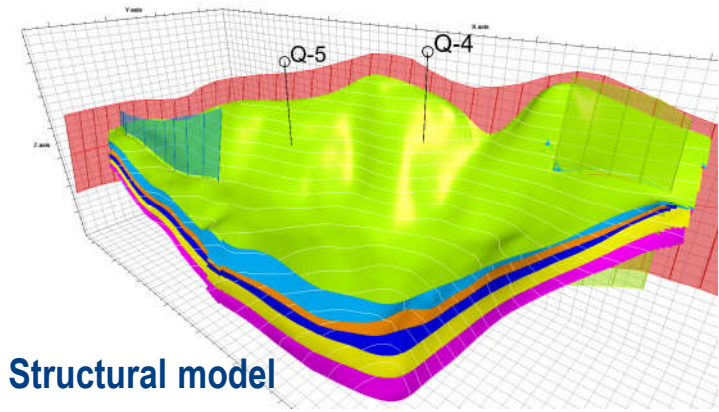
Seismic attributes slice (II)



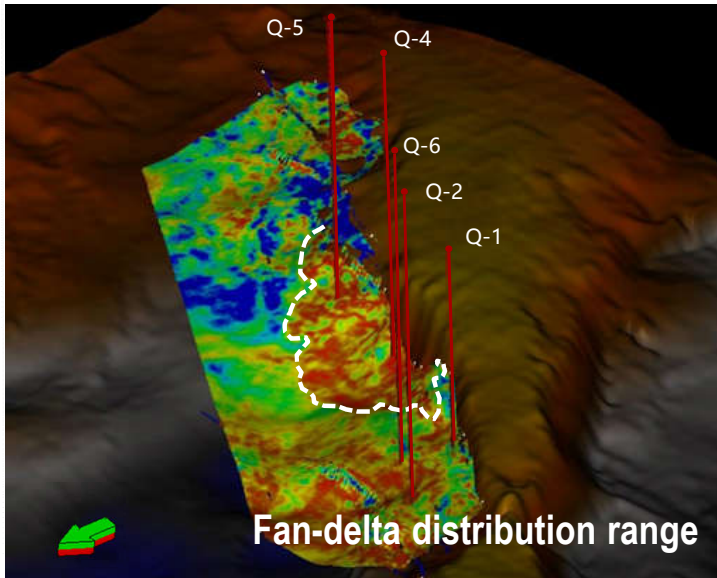
Seismic attributes slice (I-1)



Build Facies model

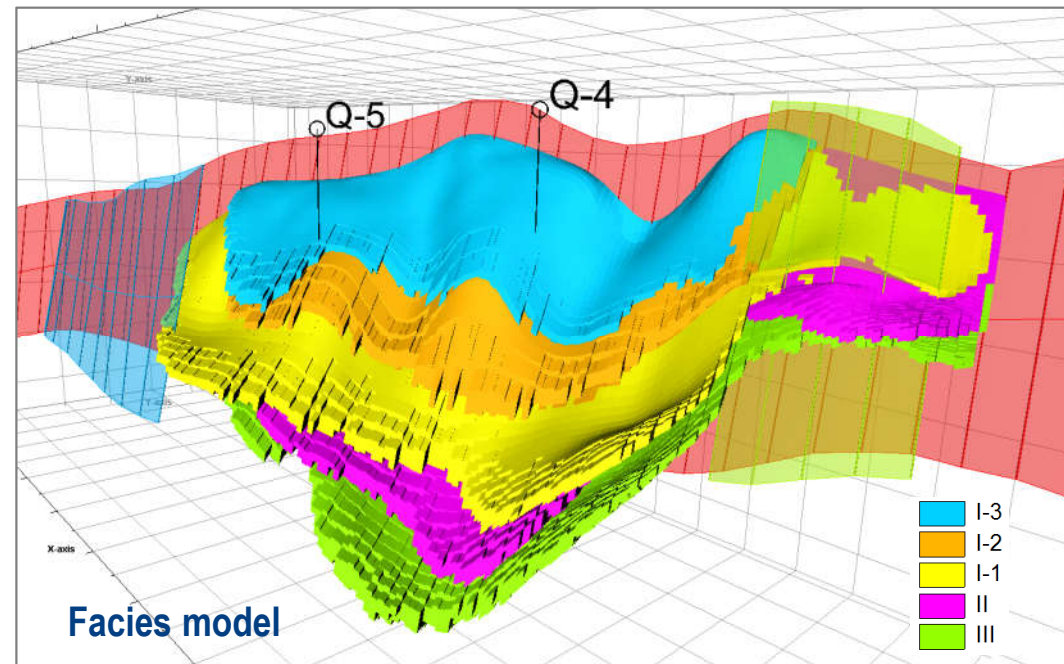


Structural model



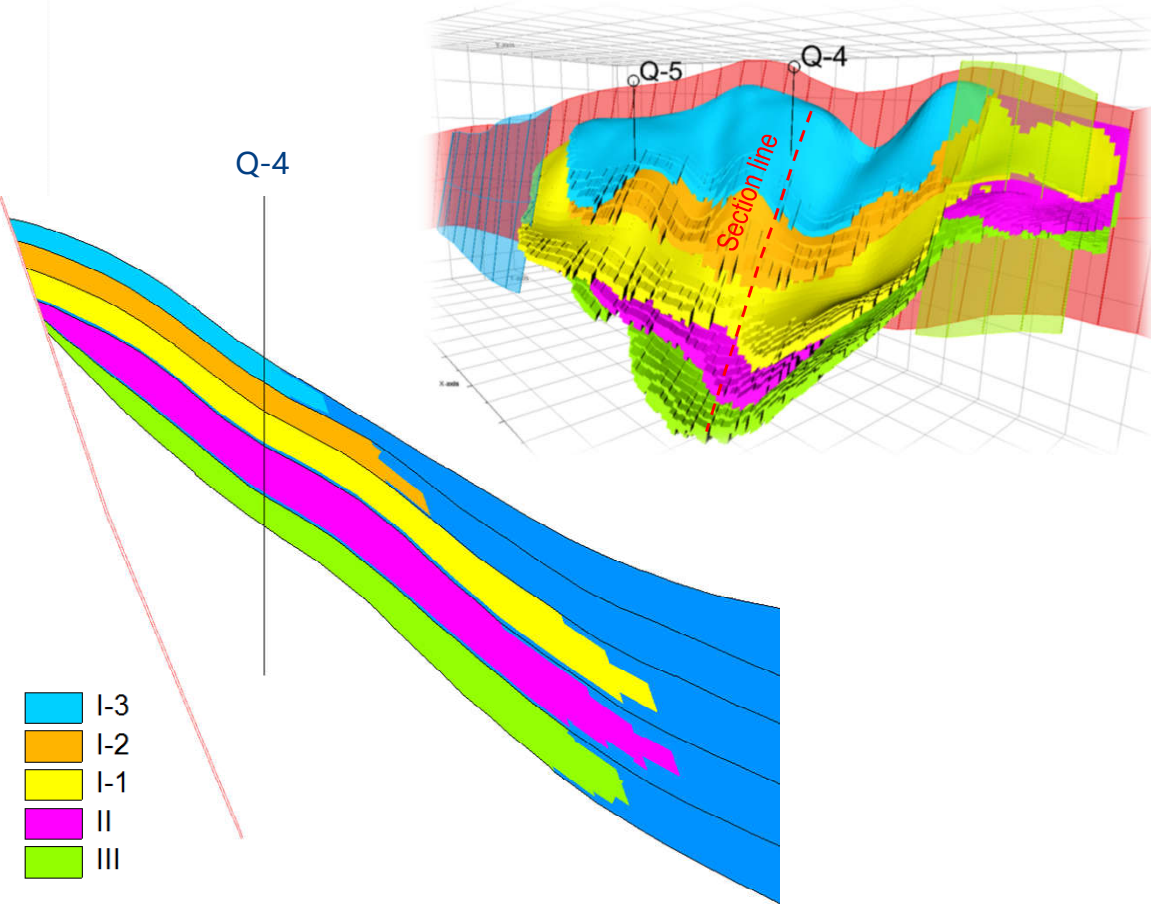
Fan-delta distribution range

Deterministic modeling method

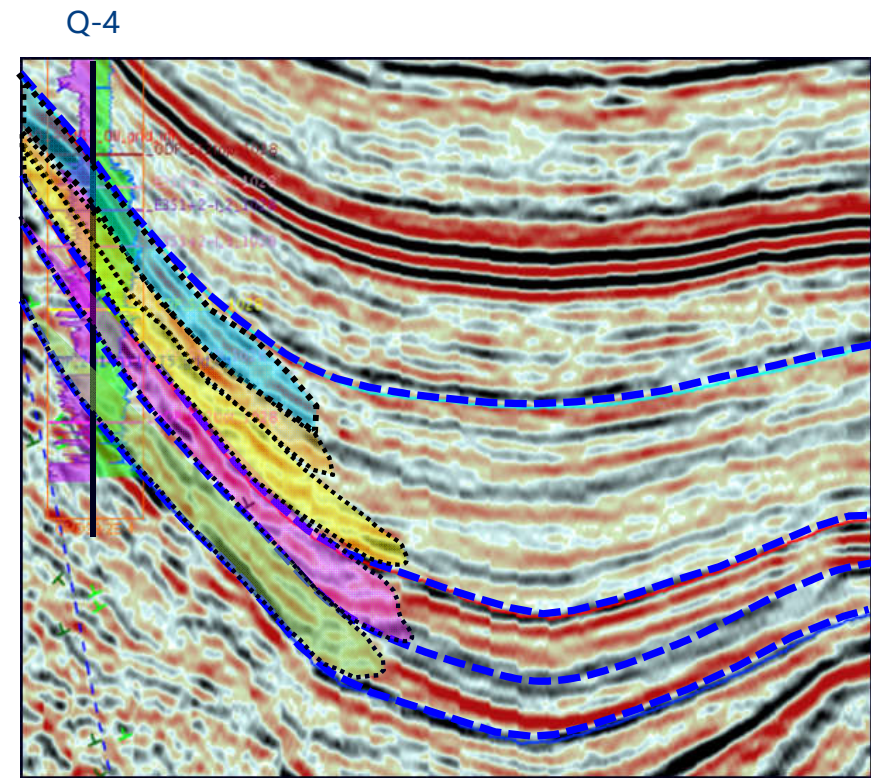


Facies model

Build Facies model



Facies model section (along the source direction)



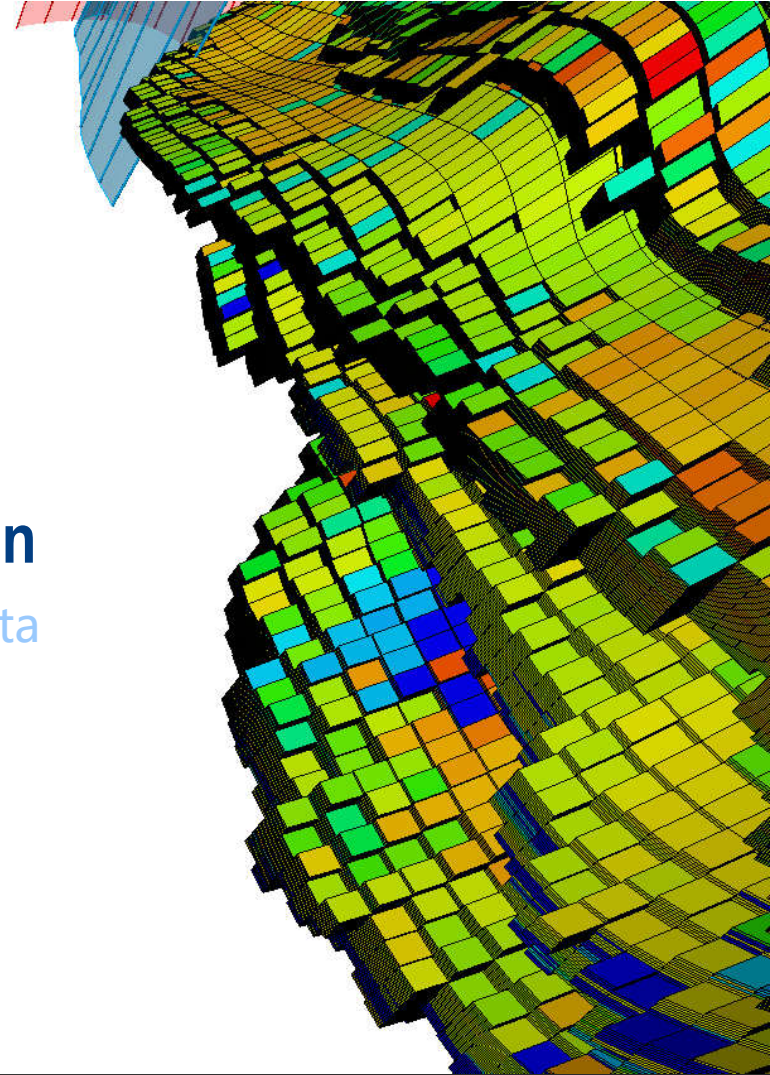
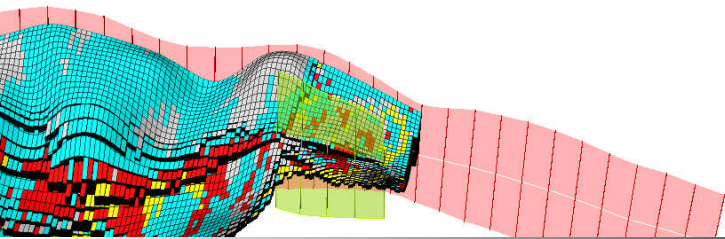
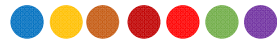
Seismic section (along the source direction)



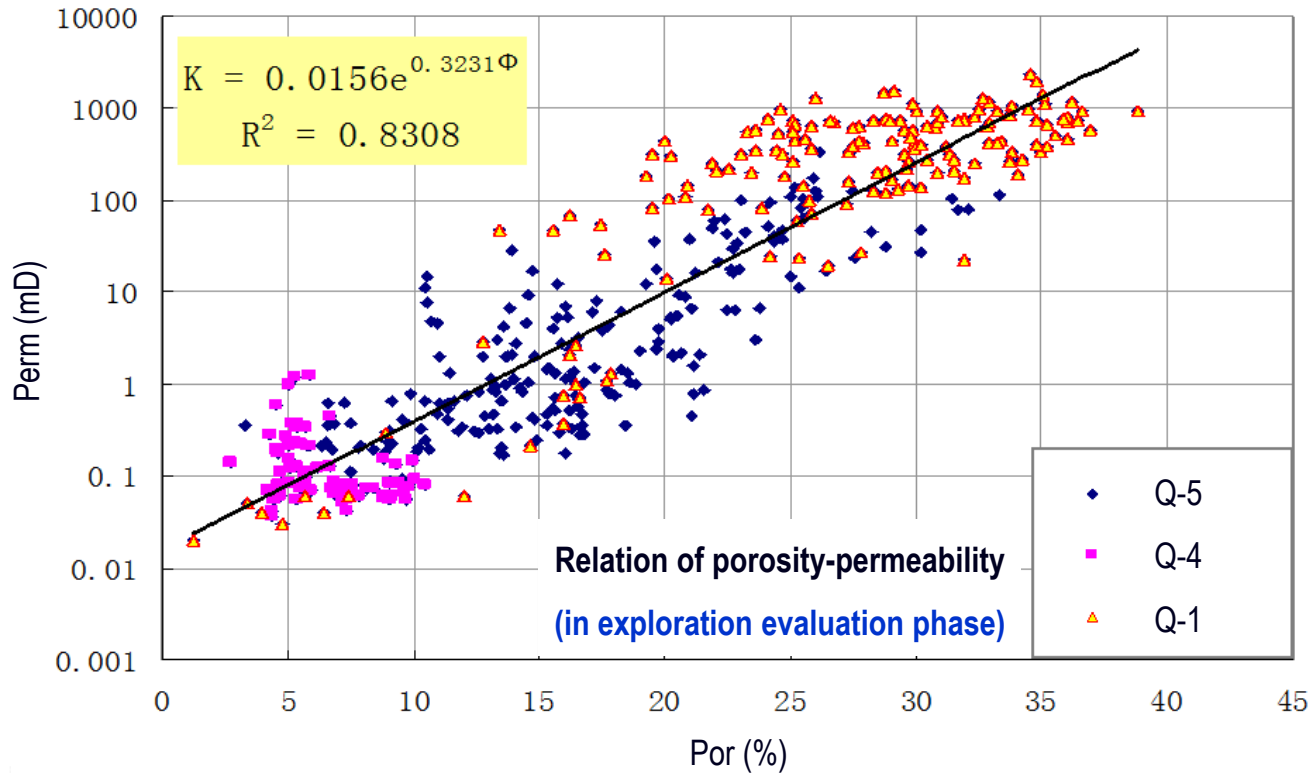
3

Constraint reservoir property distribution by lithology classification

Build Digital Reservoir of Paleogene Fan Delta



Optimize different lithological permeability interpretation



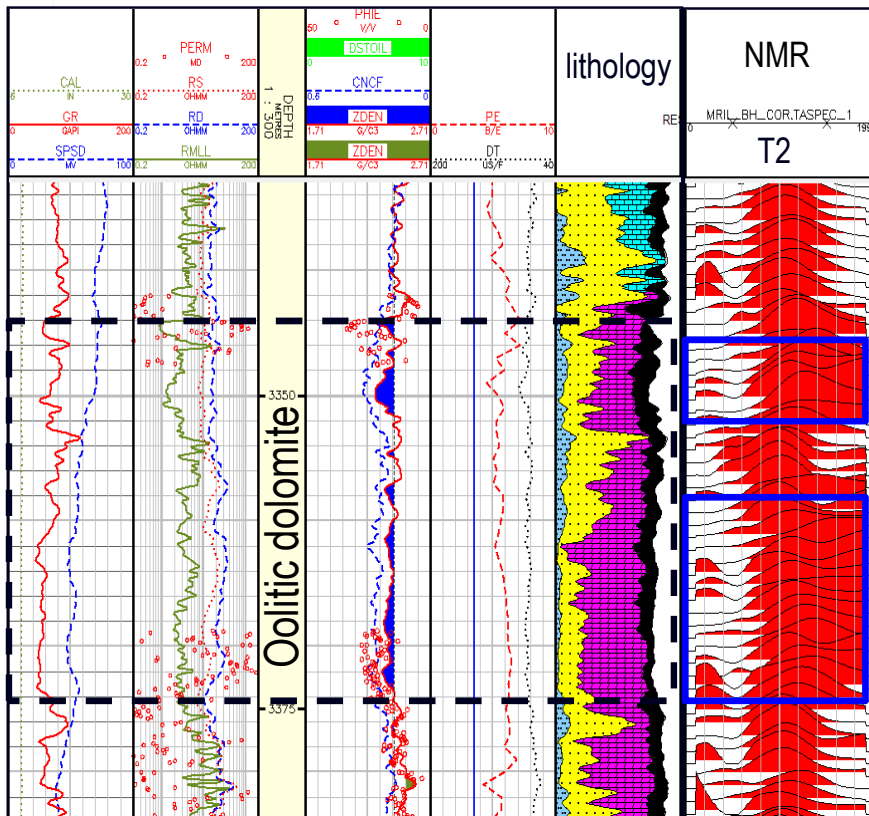
In exploration evaluation phase, the relation of porosity-permeability not built by different lithology leads to low interpretation precision.



Optimize different lithological permeability interpretation



NMR (Nuclear Magnetic Resonance) logging
response characteristics of Q-5



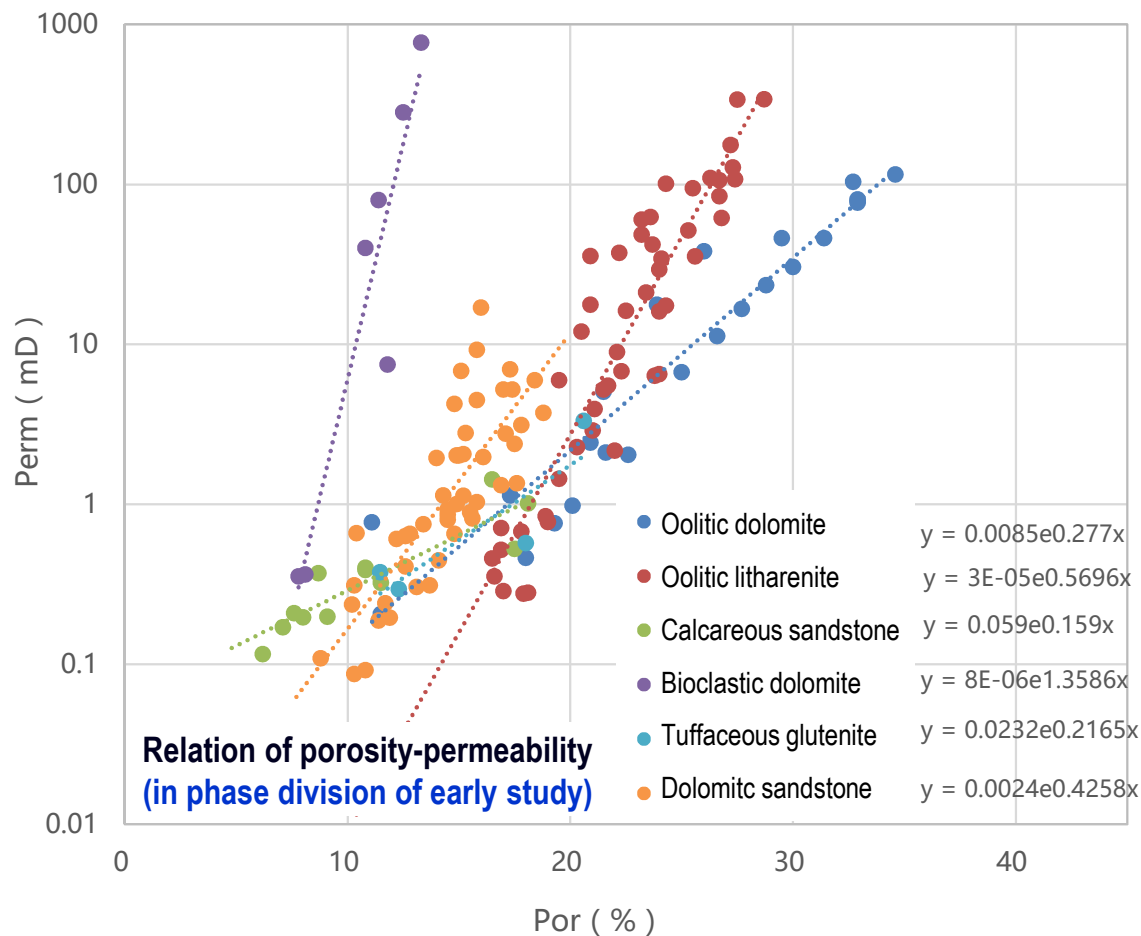
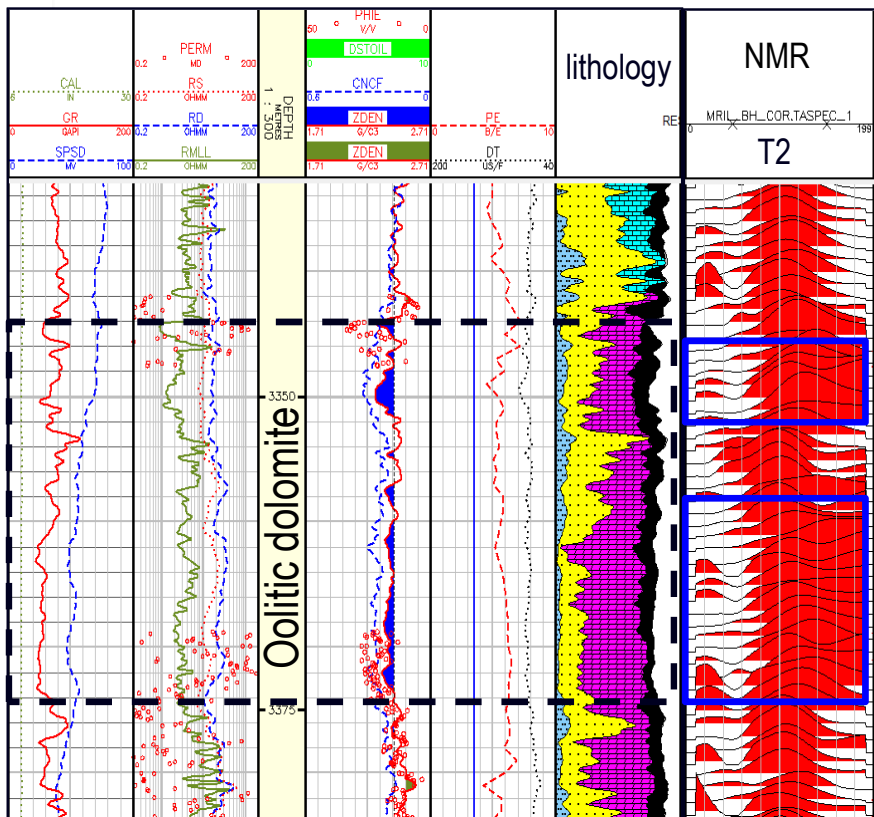
Reconstruct the relation of porosity-
permeability of basic principles :

- Similar lithology
- Similar property
- Build in different interval

Optimize different lithological permeability interpretation



NMR (Nuclear Magnetic Resonance) logging response characteristics of Q-5



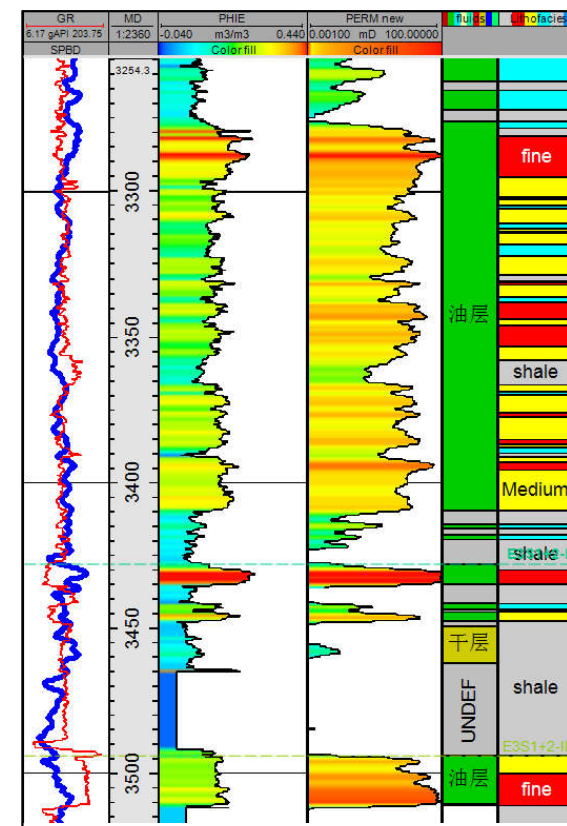
Lithofacies division



Lithofacies type division evidence

Rock type	The main lithology	Property		Micro-characteristics		
		Por (%)	Perm (mD)	Displacement pressure (Mpa)	Pc50 (Mpa)	Pore throat radius median (μm)
I (Fine)	Oolitic dolomite Bioclastic dolomite	20~25	≥10	0.041~0.71	0.8~4.2	0.17~0.92
II (Medium)	Dolomitic sandstone Oolitic litharenite Tuffaceous glutenite	15~20	1~10	0.32~2.4	8.2~24.1	0.03~0.09
III (Poor)	Calcareous litharenite	9~15	≤1	8.5~13	27~42.5	0.02~0.03

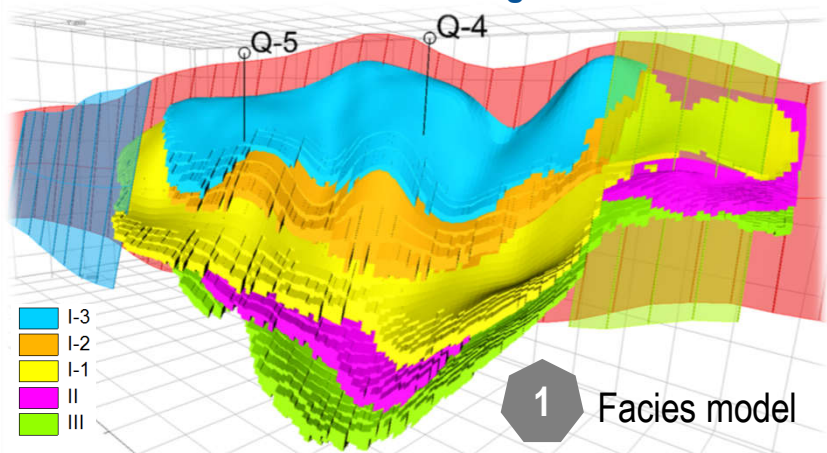
Lithofacies type division in Q-4



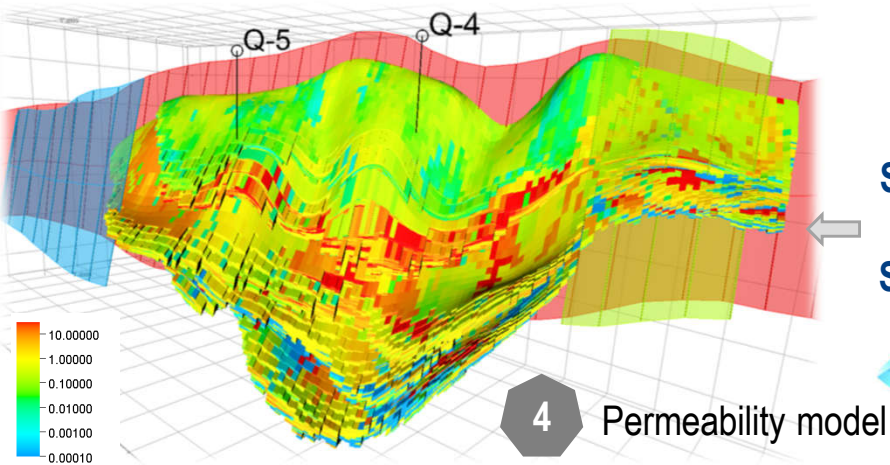
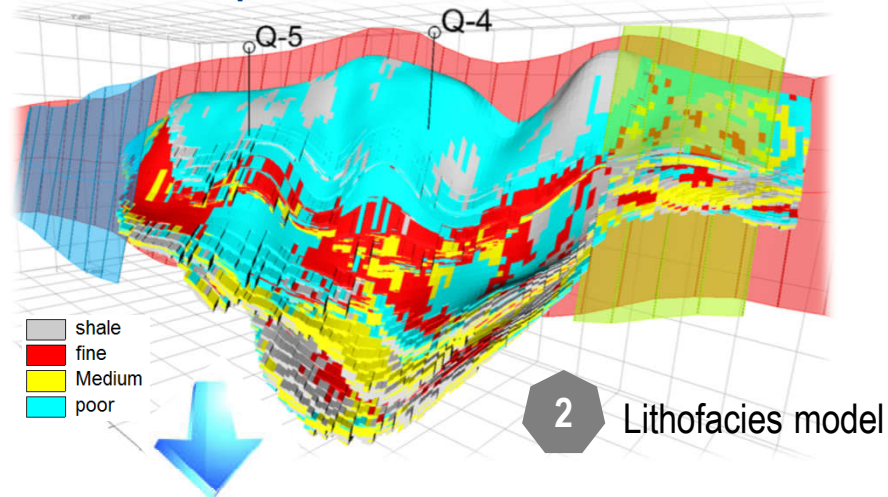
Build model with multilevel constraint method



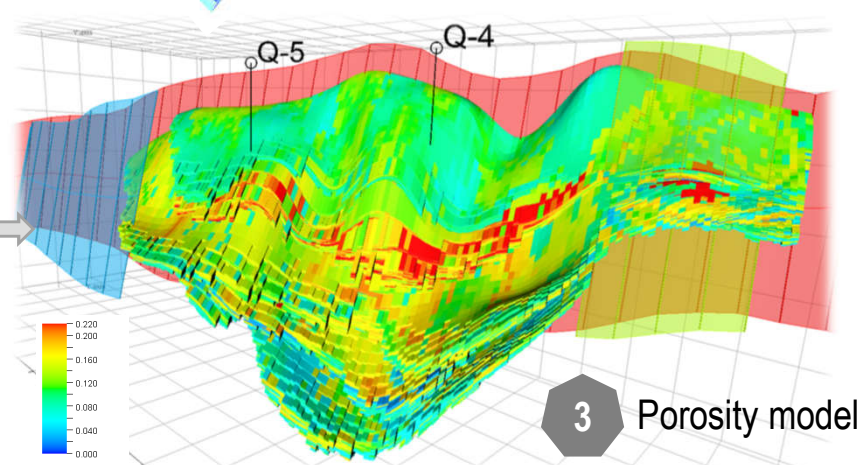
Deterministic modeling method

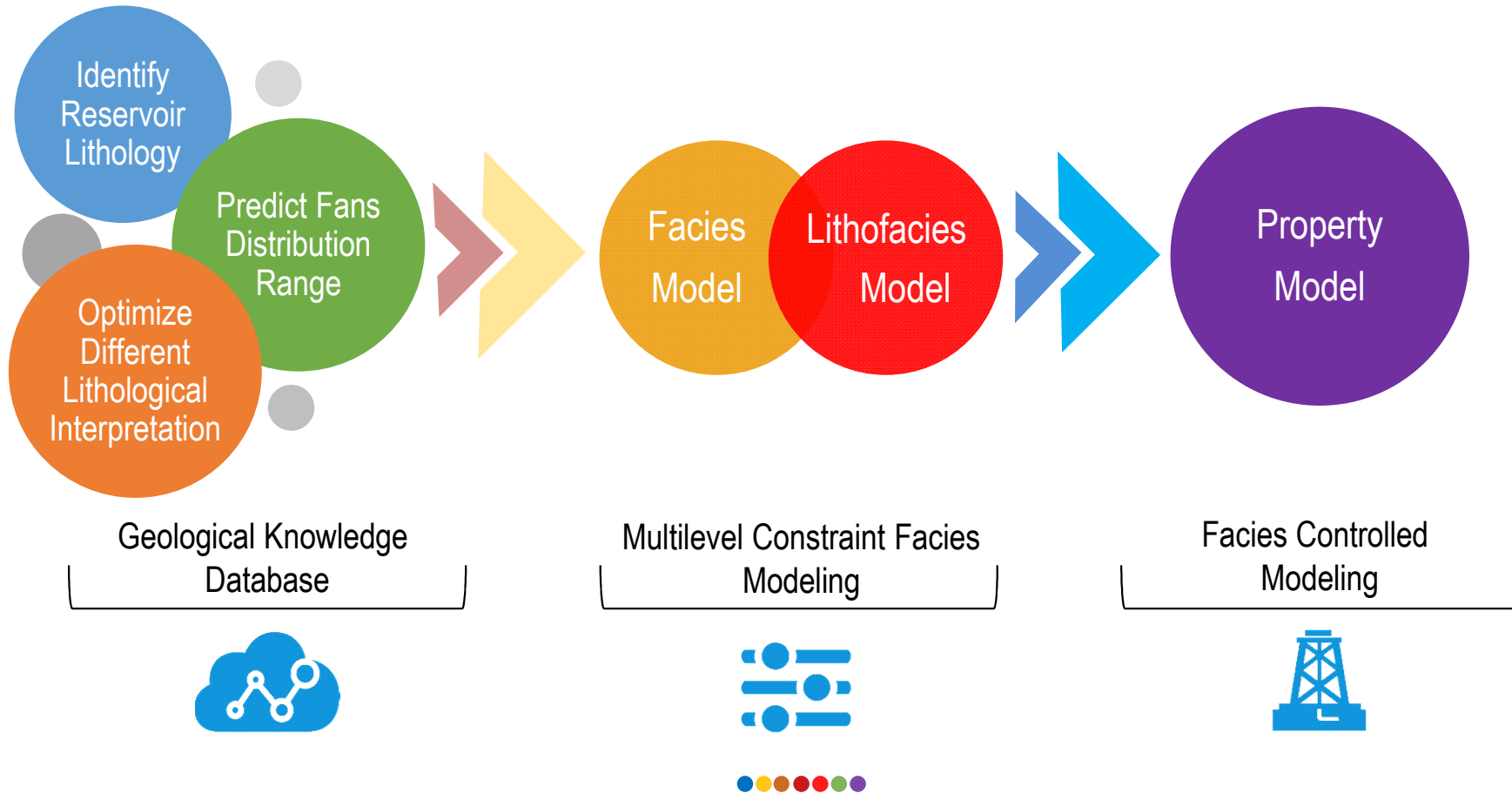


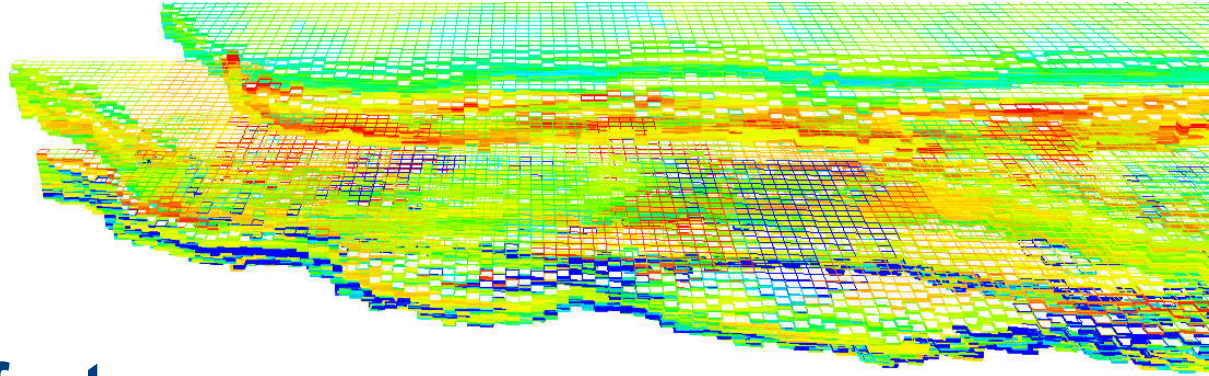
Sequential Indicator Simulation



Sequential Gaussian Simulation

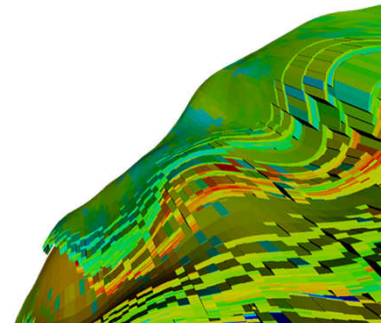
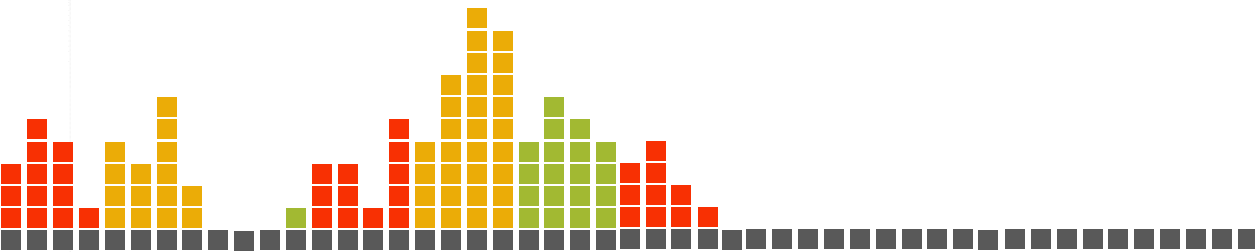
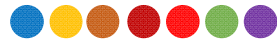




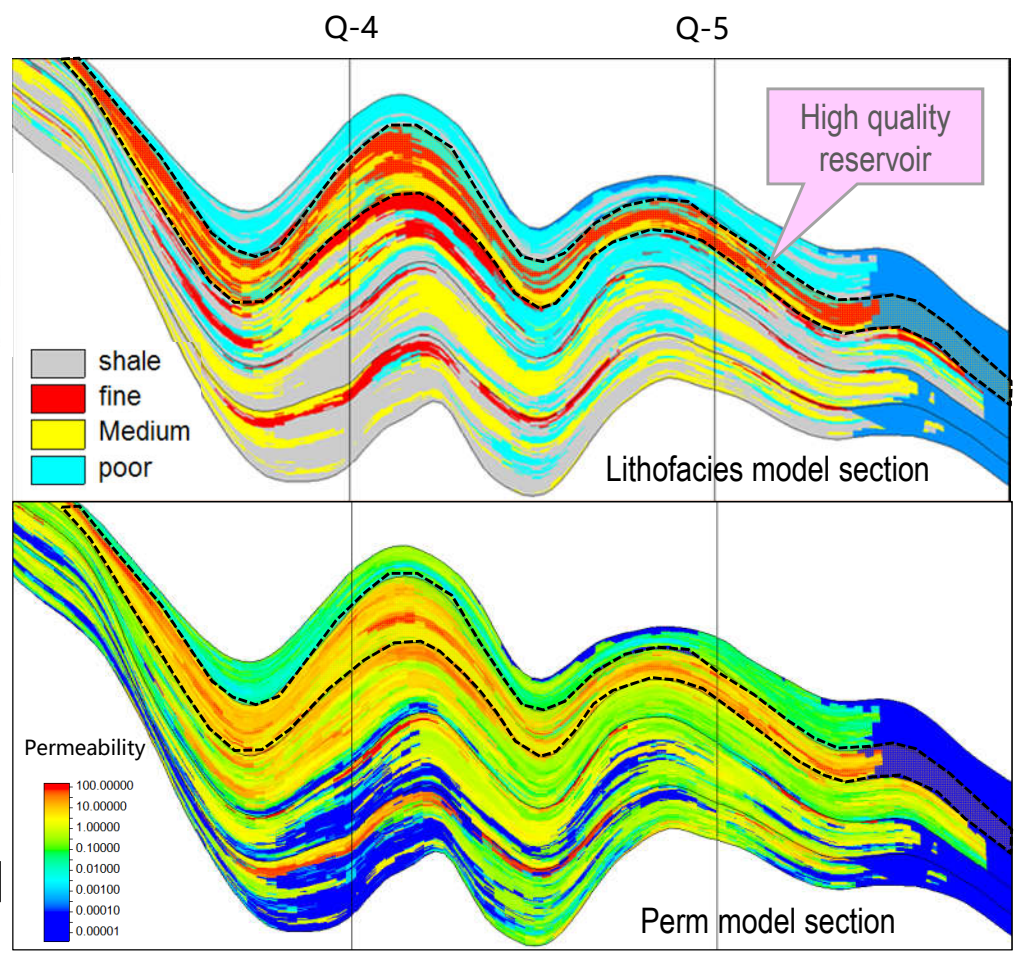
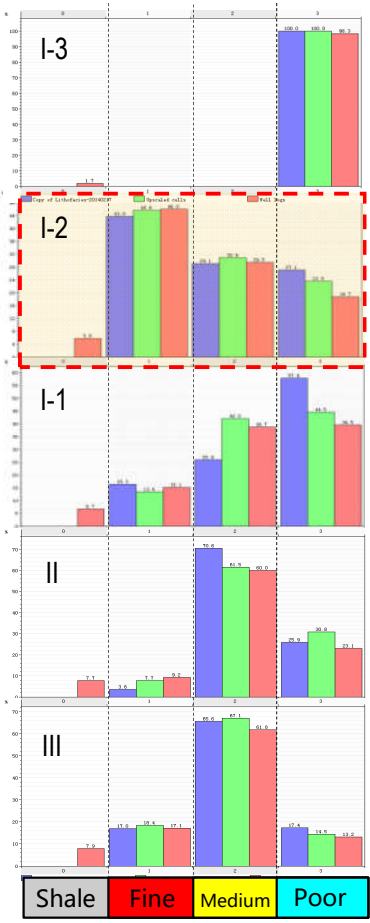
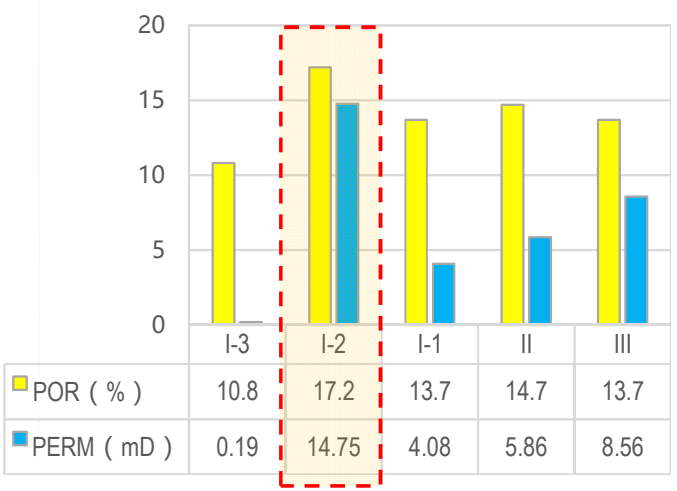
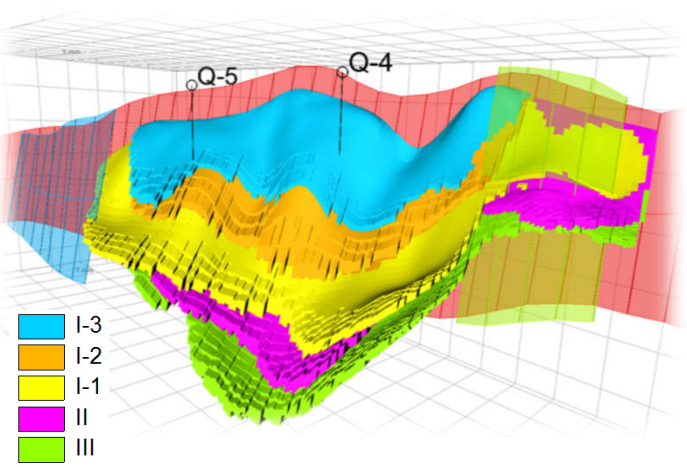


Application Effect

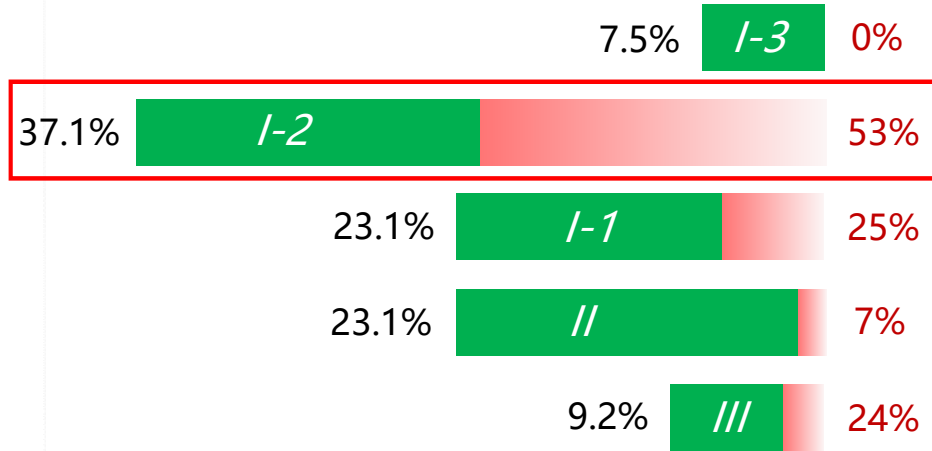
The Geomodeling of Fan-delta Reservoir
with Clastics and Carbonate in Bohai Bay



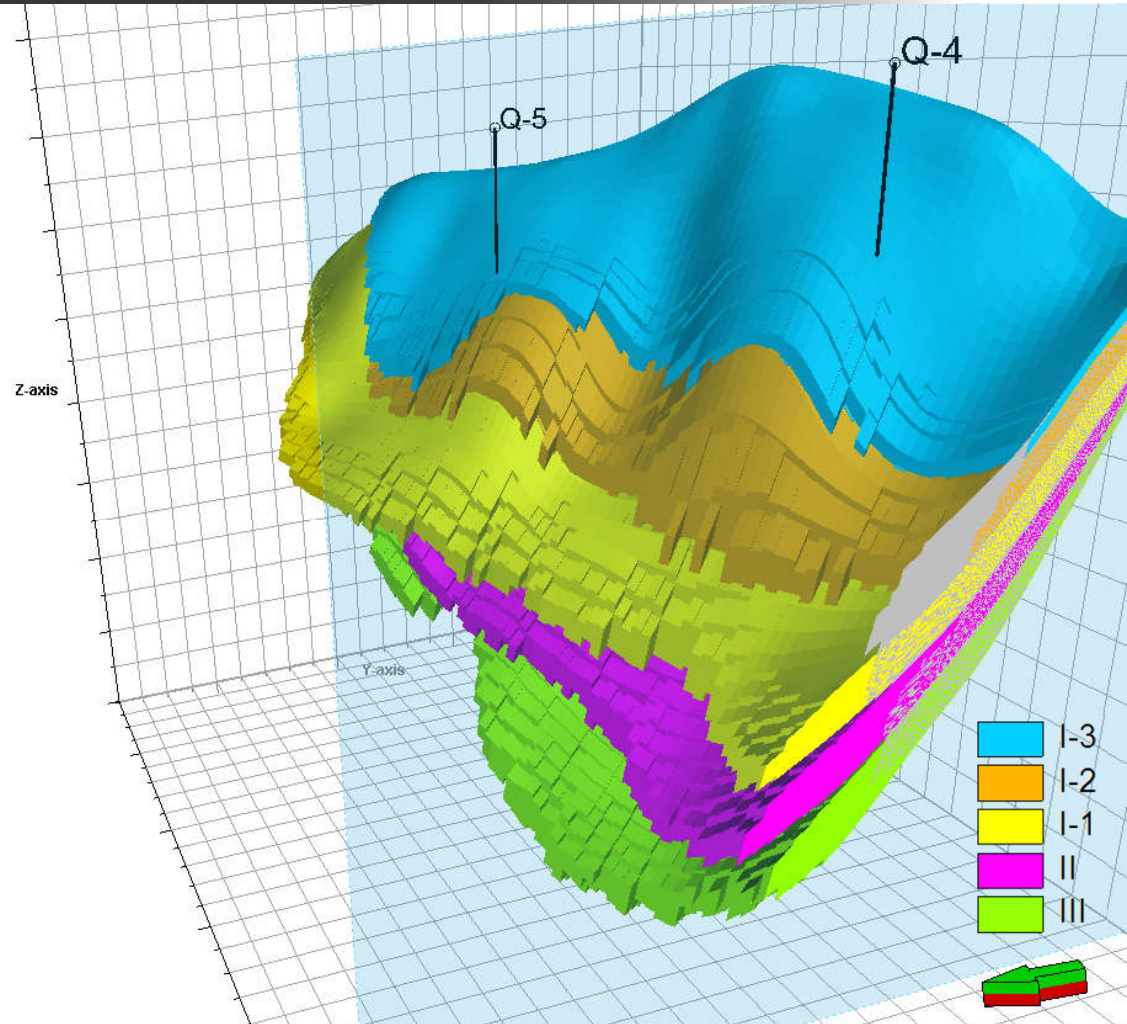
Characterize the high quality reservoir distribution



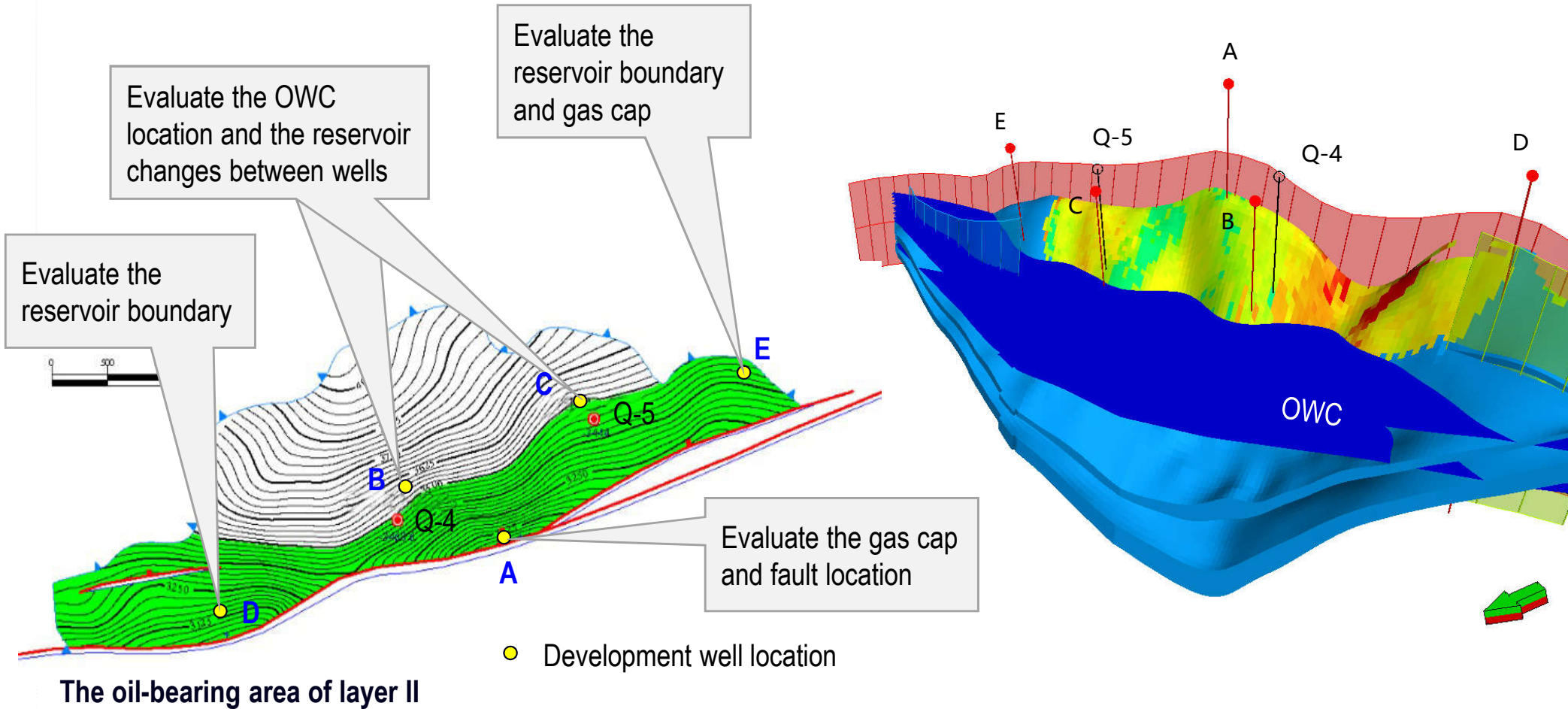
Characterize the high quality reservoir distribution



Geologic reserve distribution in different layers



Optimize well pattern and well location





- Identify the complex lithology by ECS logging and optimize different lithological permeability interpretation by NMR logging to divide the reservoir lithofacies.
- Combine seismic attribute slice analysis with lithology distribution of wells to identify different sedimentary phase of fan deltas and build fine stratigraphic framework.
- Use seismic multi-attribute analysis technology to predict sandbody distribution, then use deterministic modeling and stochastic simulation with multilevel constraints method to build lithofacies model.
- Use the lithofacies model as constraint to establish property model with stochastic simulation method.
- The model does not only subdivide the reservoir but also make the high quality reservoir distribution clearly.



END



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