



# **Application of Petromod and Petrel in Comprehensive Evaluation of Oil and Gas Three- dimensional Migration and Transportation**

**Yuling SHI**

**CNOOC China Ltd. \_Shenzhen.**



# Content

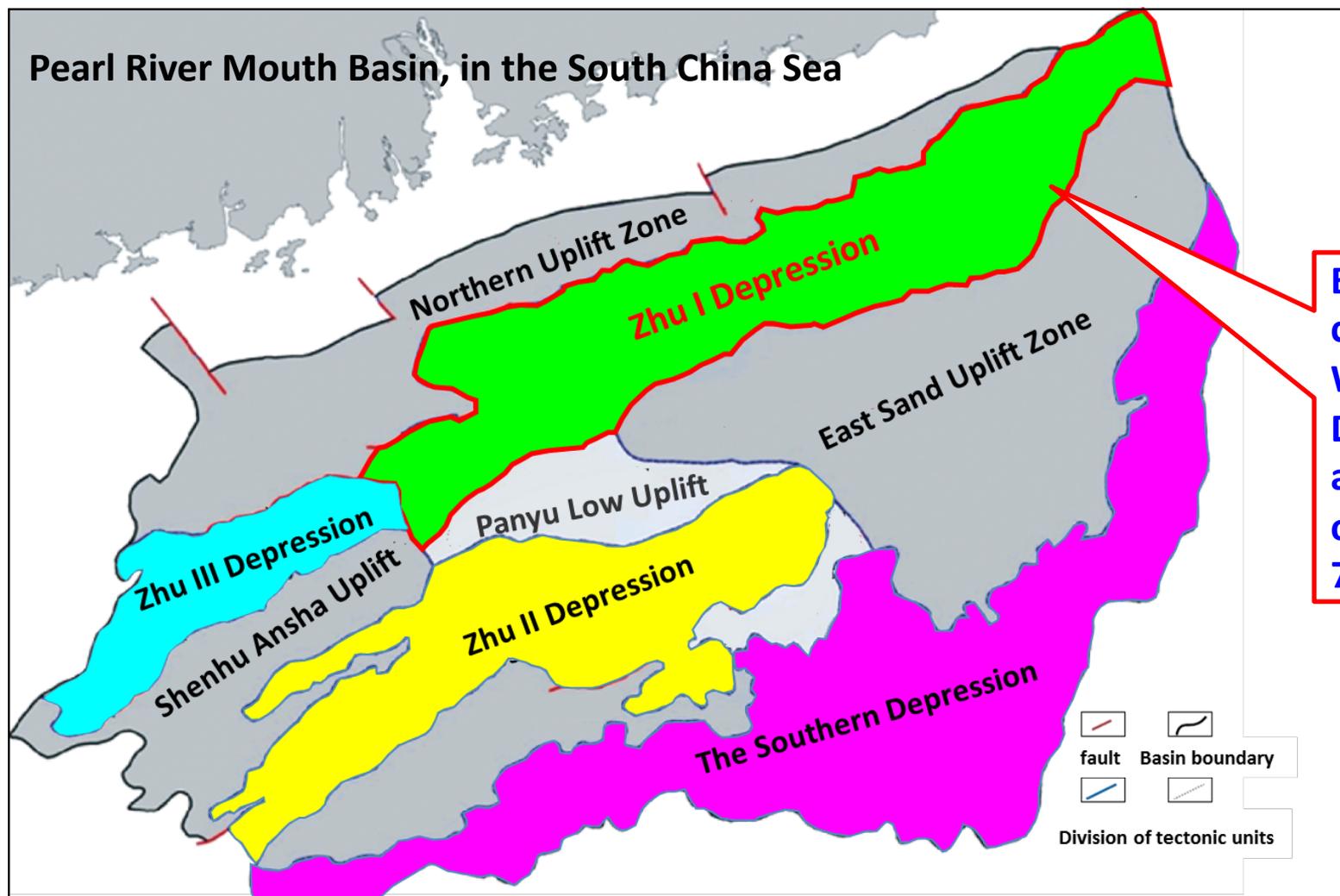
---

- **Research Background**
- **Key technologies and innovations**
- **Main results of the study**
- **Conclusions and recommendations**



# Research status of hydrocarbon migration and accumulation

Source rock and hydrocarbon migration is one of the key factors restricting oil and gas accumulation.

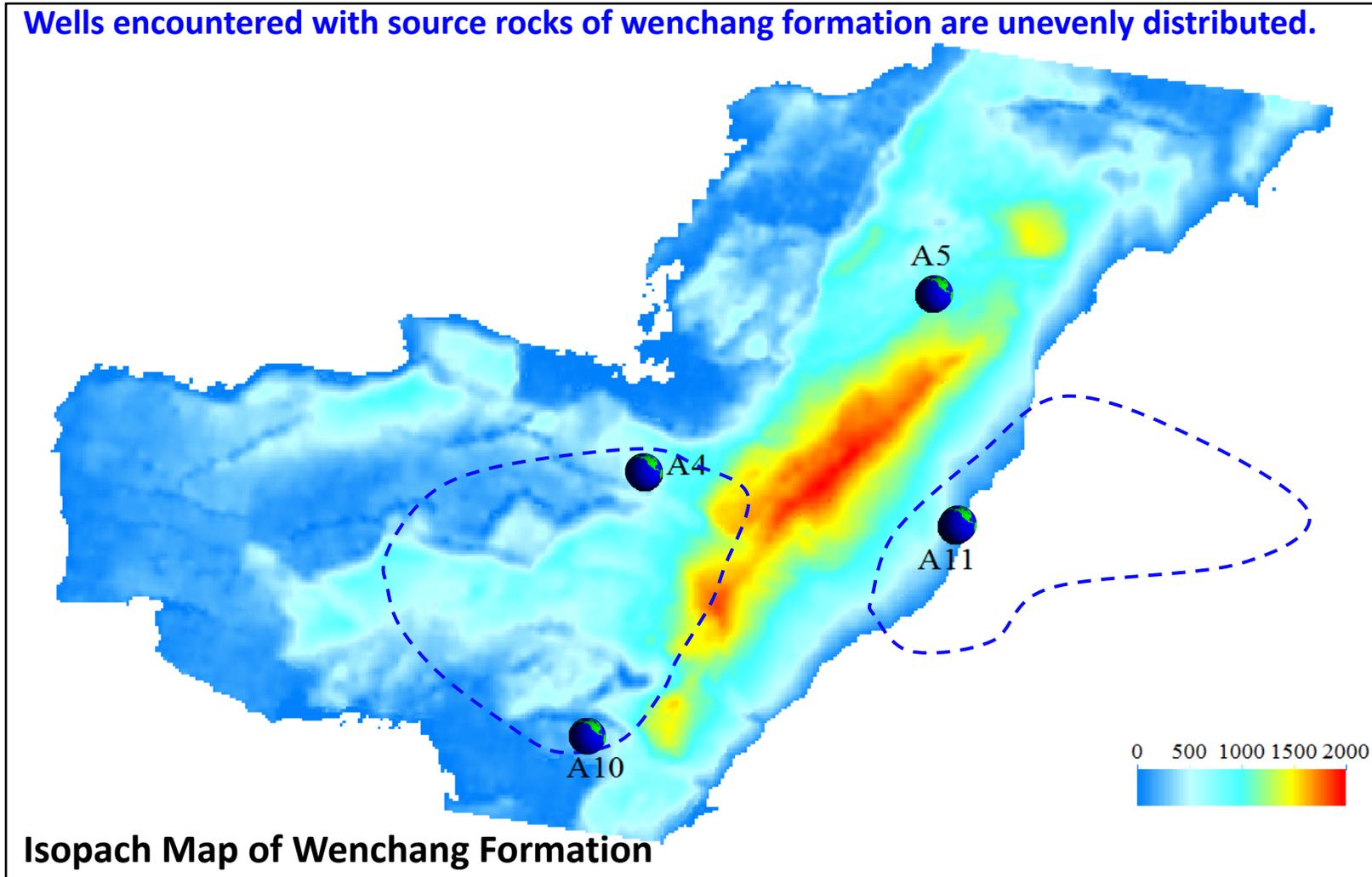


By early 2019, about 190 commercial failed drilling Wells.  
Due to source rocks and accumulation, the number of failed wells has exceeded 70%.



# Key technical issues

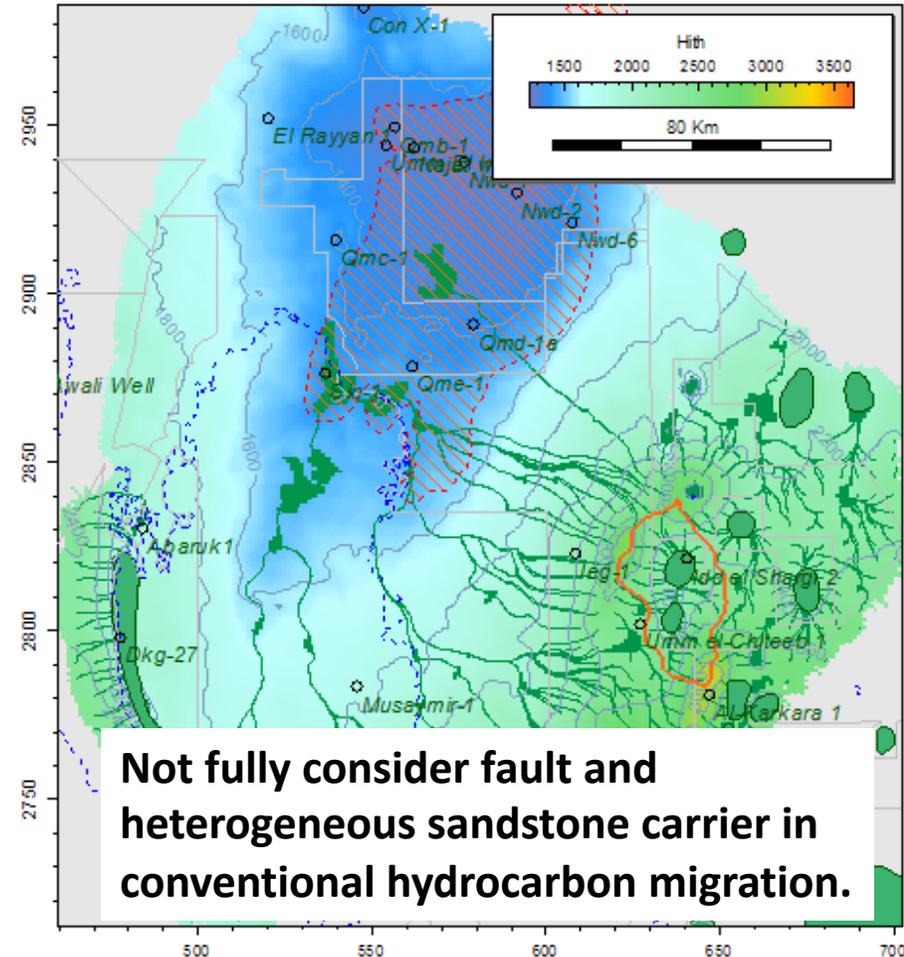
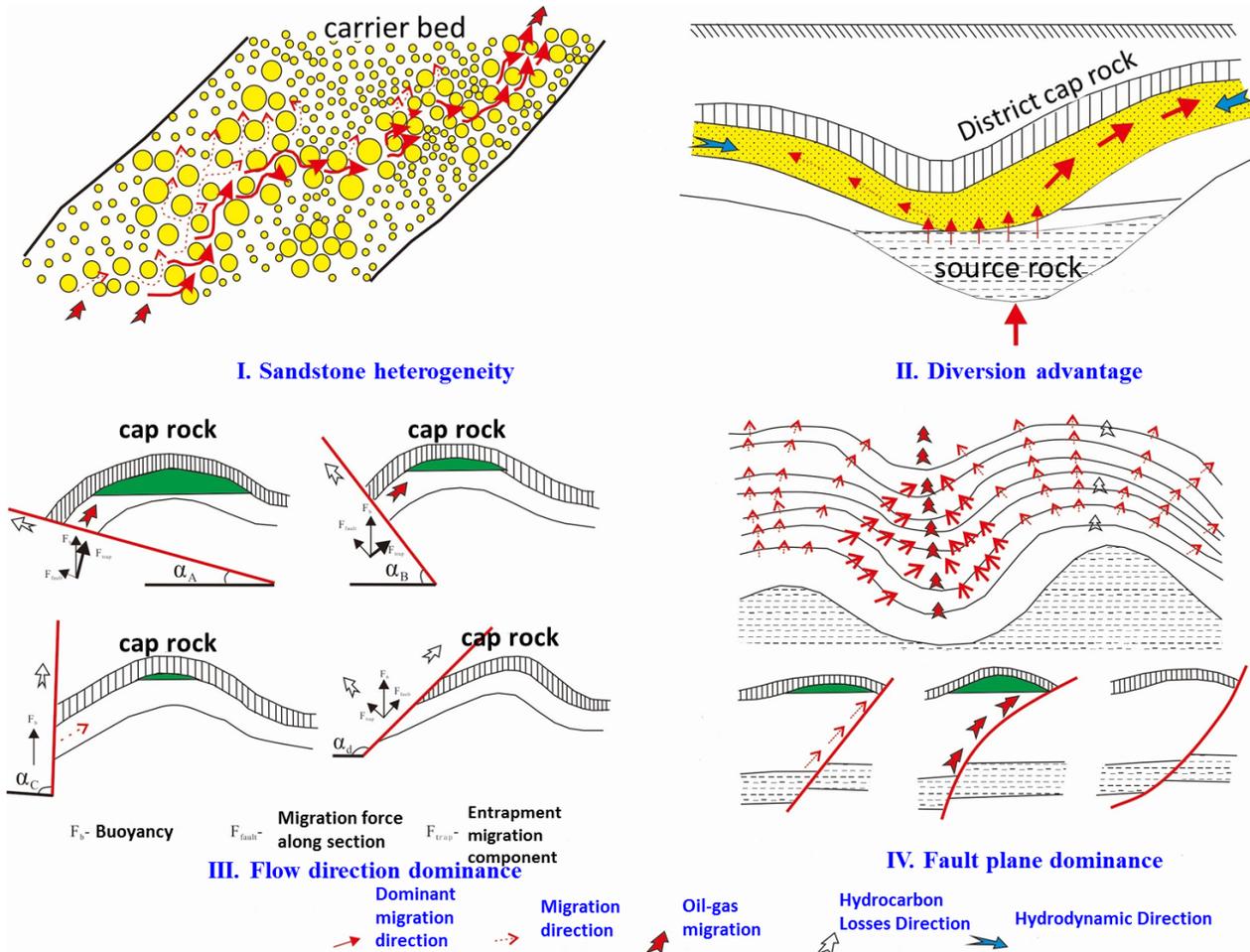
1. How to accurately evaluate hydrocarbon potential of source rocks through limited drilling to guide oil and gas exploration?





# Key technical issues

**2. How to apply the factors, such as fault flow direction and plane dominance, heterogeneity and diversion advantage of sandstone carrier, to the three-dimensional geological framework composed of fault and sandstone, controlling hydrocarbon migration?**

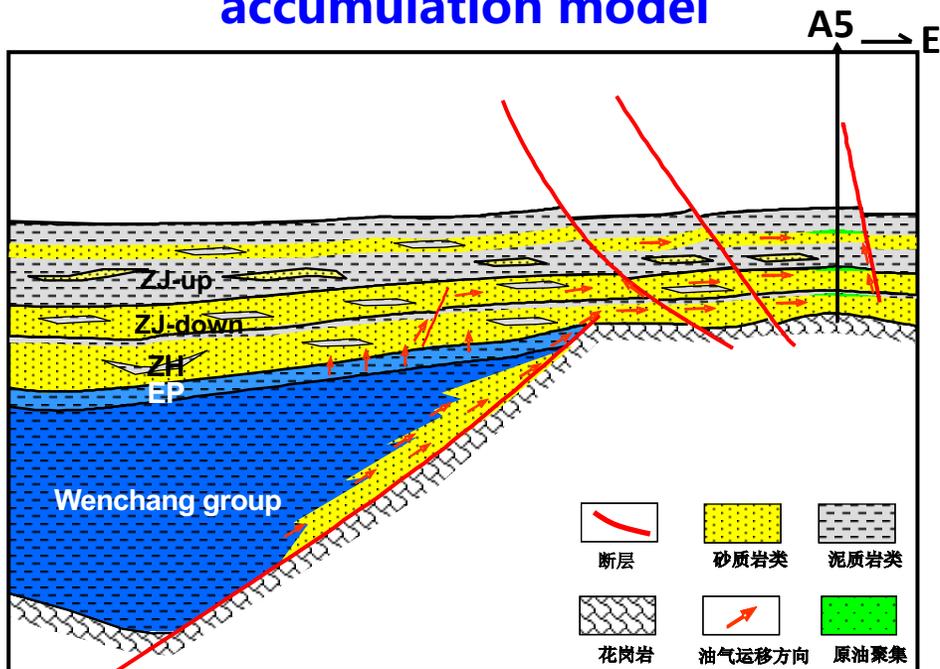




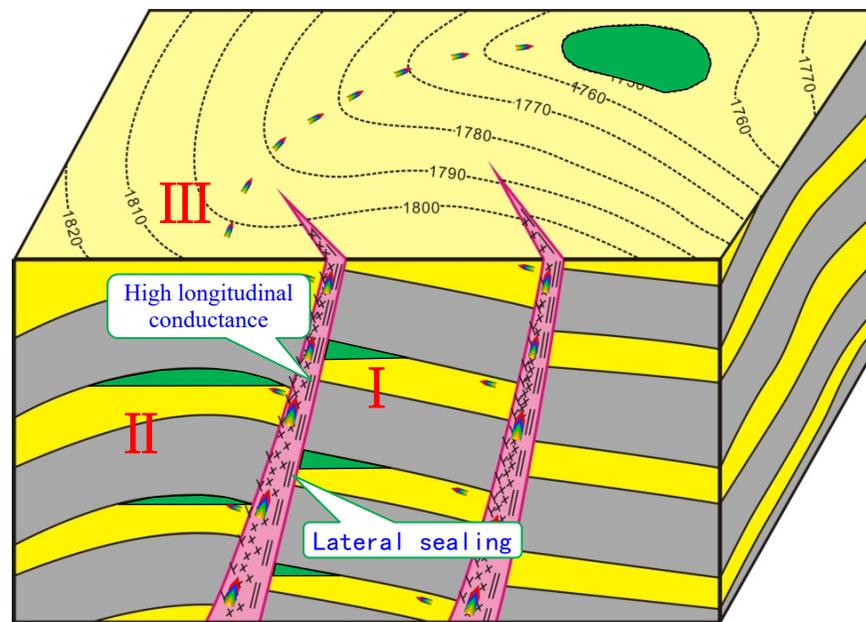
# Key technical issues

3. How to set up the three-dimensional hydrocarbon migration and accumulation model to guide oil and gas exploration accurately, instead of the traditional conceptual model?

### Two-dimensional migration and accumulation model



### Three-dimensional migration and accumulation model





# Content

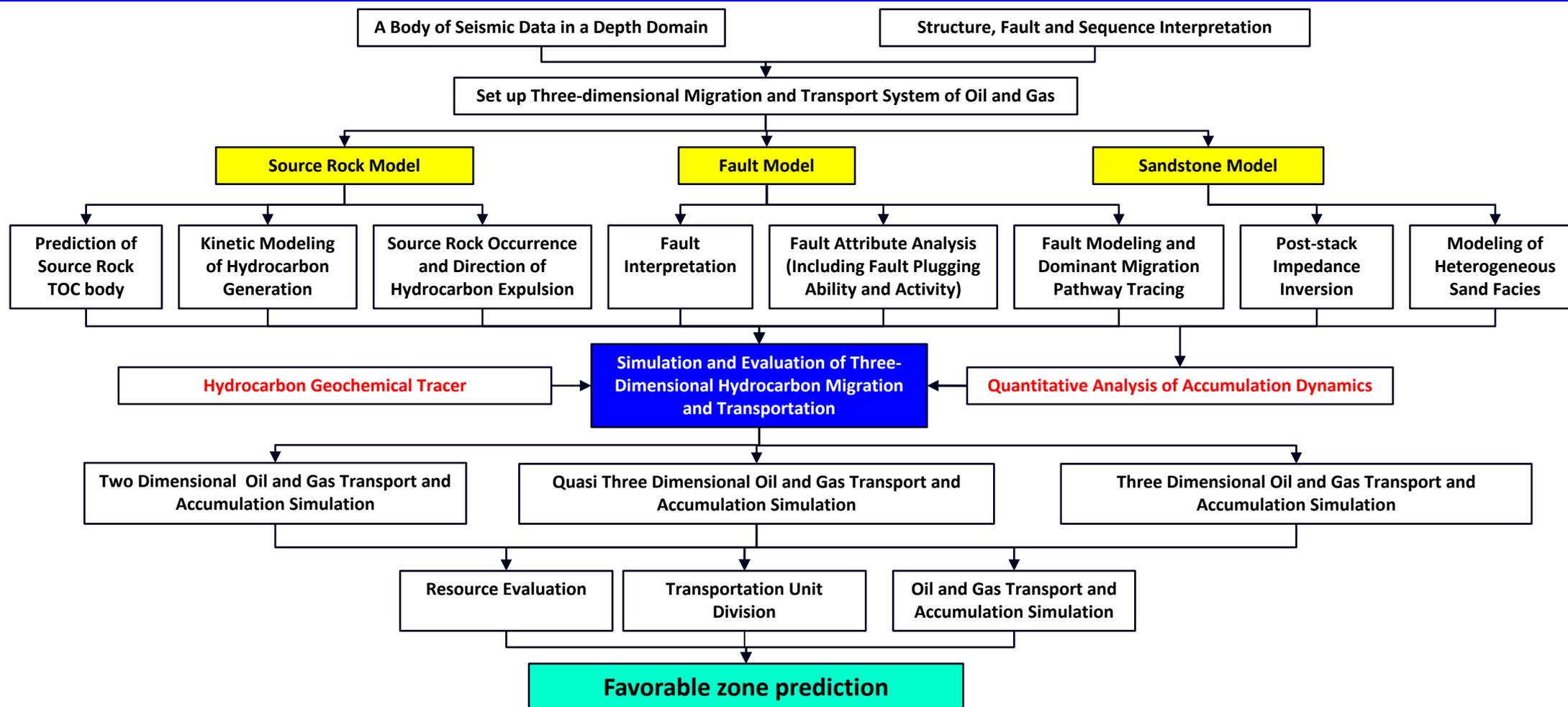
---

- **Research Background**
- **Key technologies and innovations**
- **Main results of the study**
- **Conclusions and recommendations**



# Comprehensive evaluation technology of three-dimensional hydrocarbon migration and accumulation

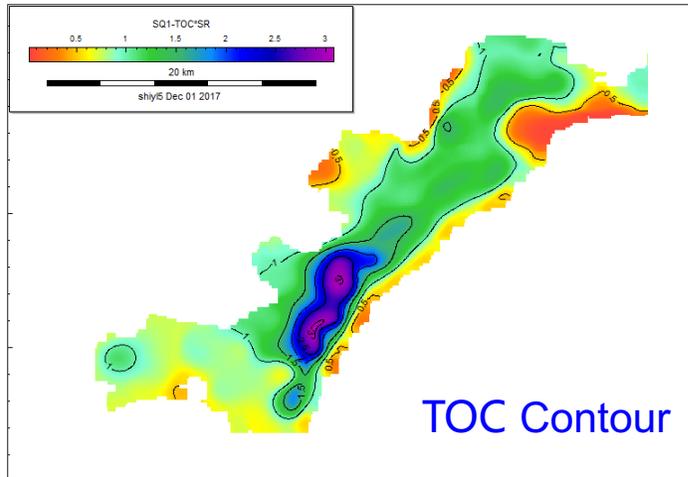
Set up three-dimensional geological framework → Hydrocarbon geochemical tracer → Three-dimensional hydrocarbon migration and accumulation simulation → Predict the favorable zone and target





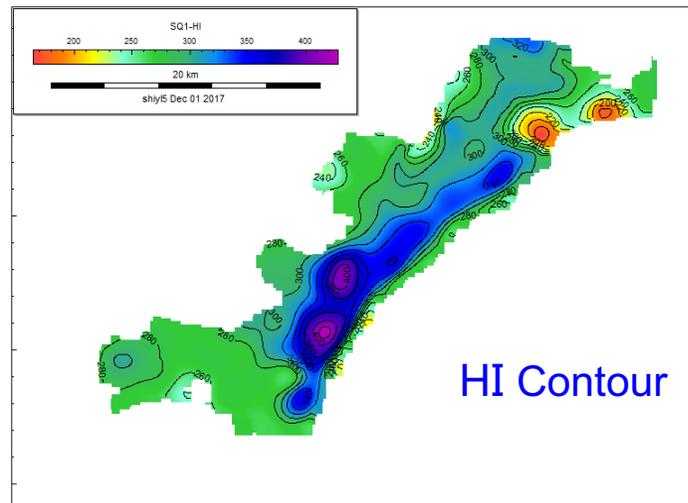
# The first innovation: Organic Facies Modeling of Source Rocks

The TOC body of source rock is predicted quantitatively by **well-seismic method**, instead of well control interpolation, and the three-dimensional organic facies model of source rock is established in the TOC body, which ensures **the horizontal and longitudinal heterogeneity of source rock** and **controls hydrocarbon migration and accumulation**.

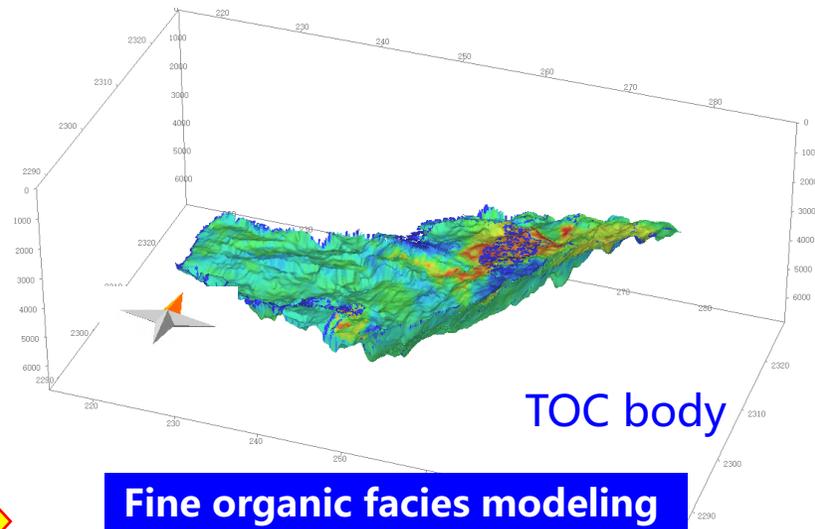
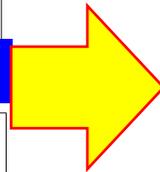


TOC Contour

Traditional organic facies modeling

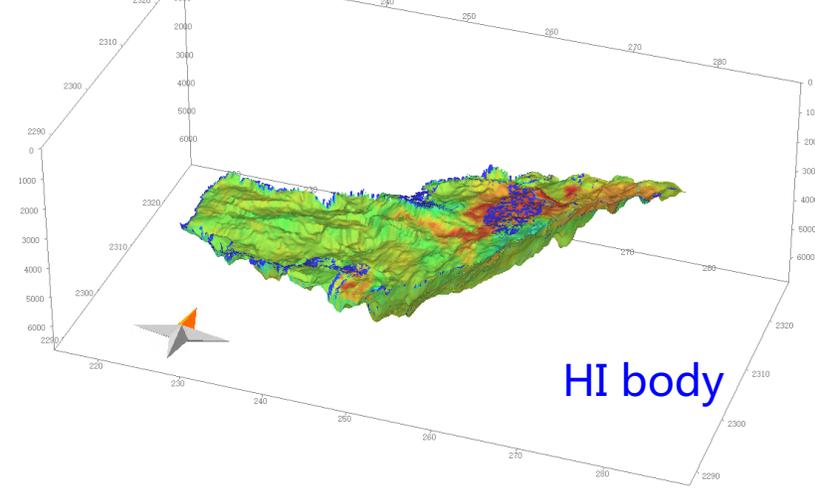


HI Contour



TOC body

Fine organic facies modeling

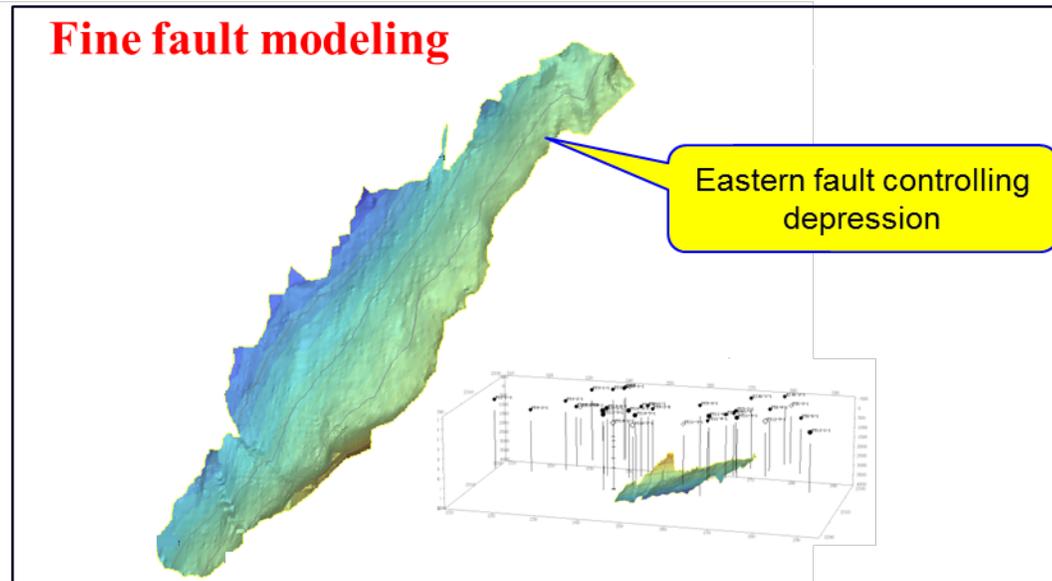
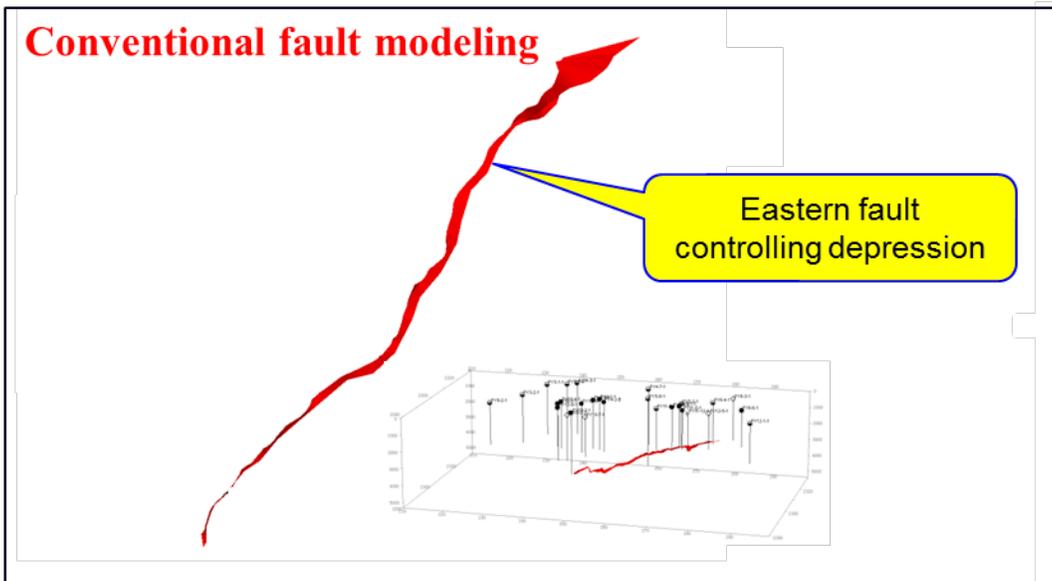


HI body





# The third innovation: Fault Modeling

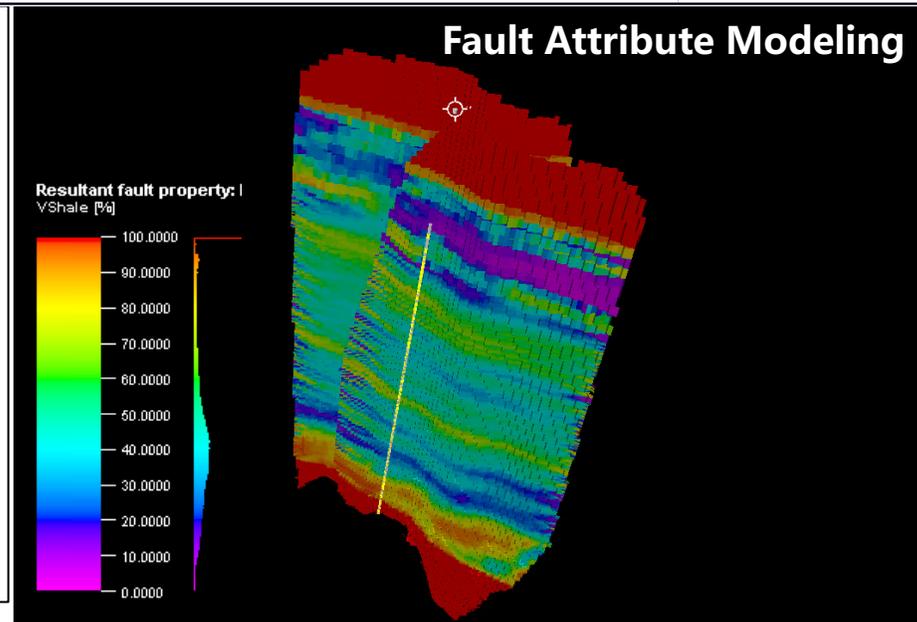


## ➤ Conventional fault modeling

Ignore the fault's original form

## ➤ Fine fault modeling

Established through fault sticks rather than fault polygon, which **ensures fault morphology and factual contact relationship between the fault and the horizon**. Based on lithofacies modeling, we have analysed fault attribute for studying trap effectiveness.



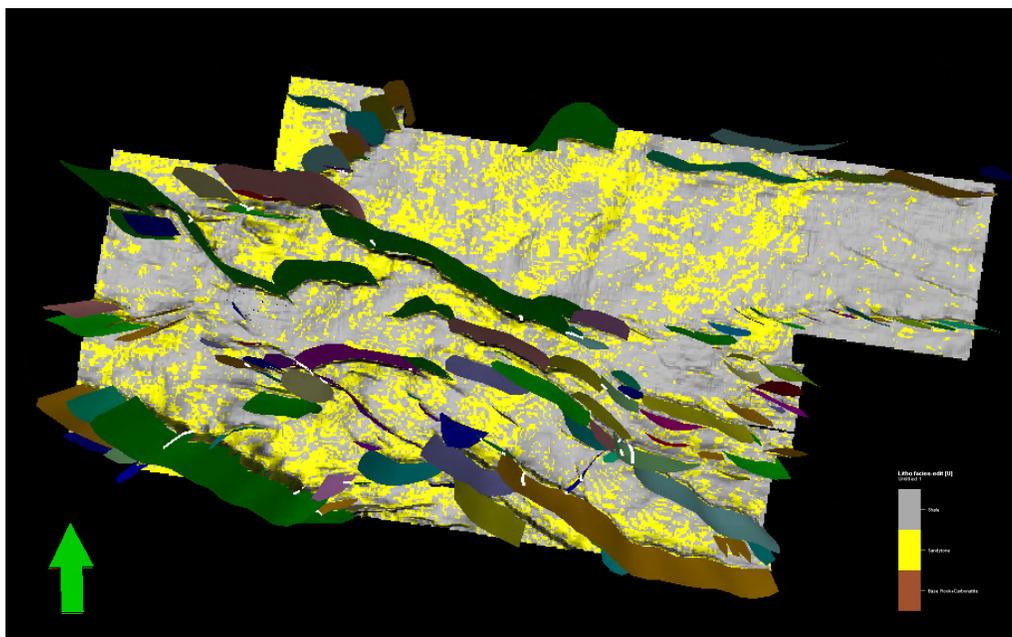


# The fourth innovation: Fine Geological Modeling and 3D Quantitative Simulation of Hydrocarbon Transport and Accumulation

Petrel-Fine Modeling

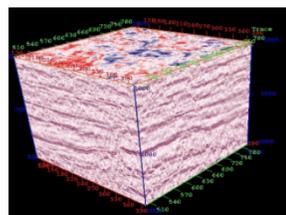
Petromod - Fine Petroleum System Simulation

Petrel-Show Directly

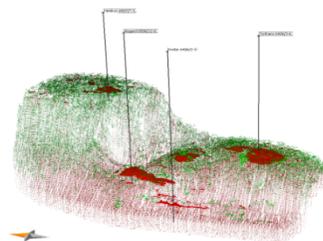


- Fine geological modeling is an organic combination of **hydrocarbon source rocks(Six sets), fault and sandstone carrier and boundary conditions**, which includes the characteristics of large working area(More than 1000 Square kilometers, for petroleum system), multiple layers(More than 10 layers) and complex attributes.
- The method ensures the establishment of three-dimensional geological framework with faults and sandstone, and **3D hydrocarbon migration and accumulation simulation** was carried out in the oil and gas area by **combining macroscopic geophysical, microcosmic geochemical studies and actual oil and gas shows.**

Forward



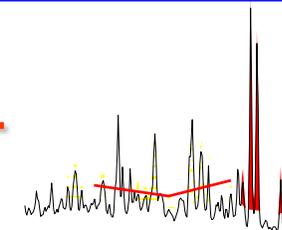
**Geophysics**  
( geologic framework )



**Basin modeling**  
( Simulation of hydrocarbon migration and accumulation )



**Actual well**  
( Oil and gas shows )



**Geochemistry**  
( Oil source correlation )

Inversion



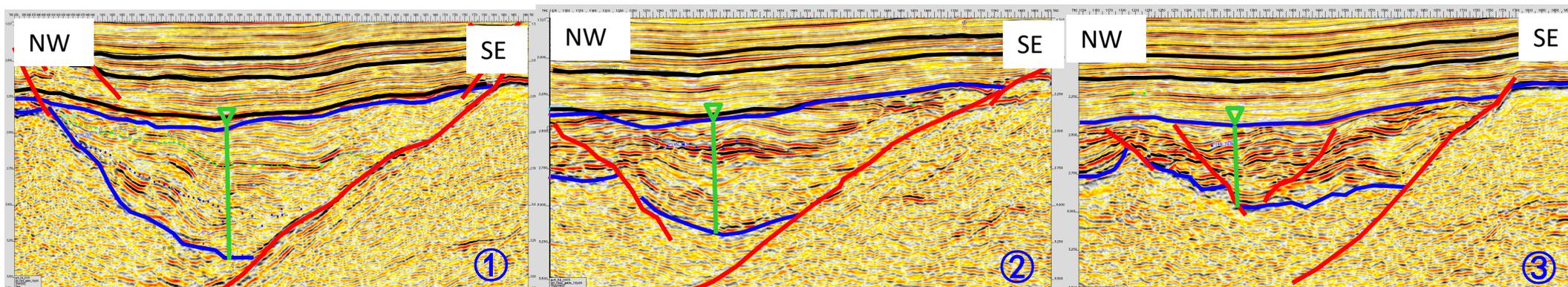
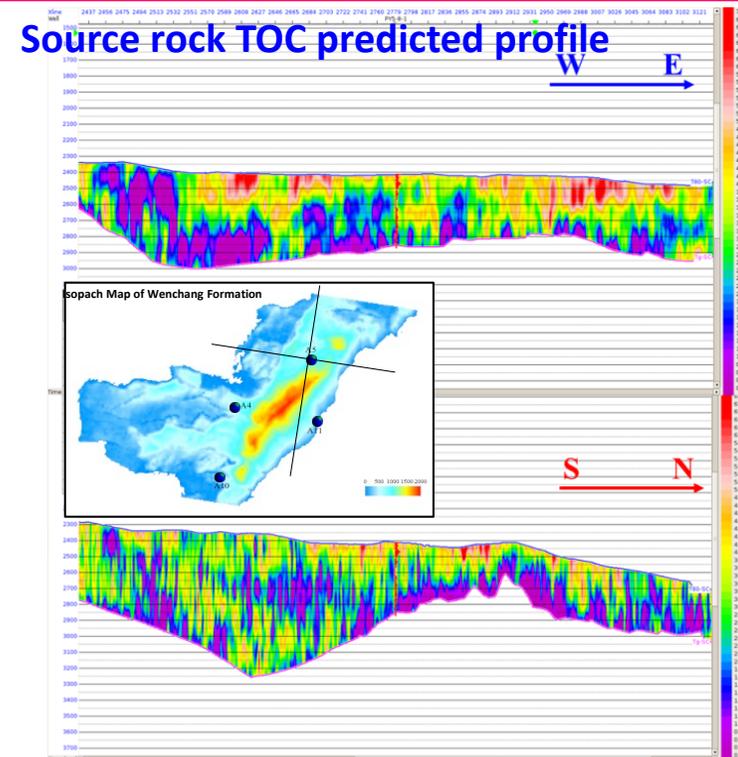
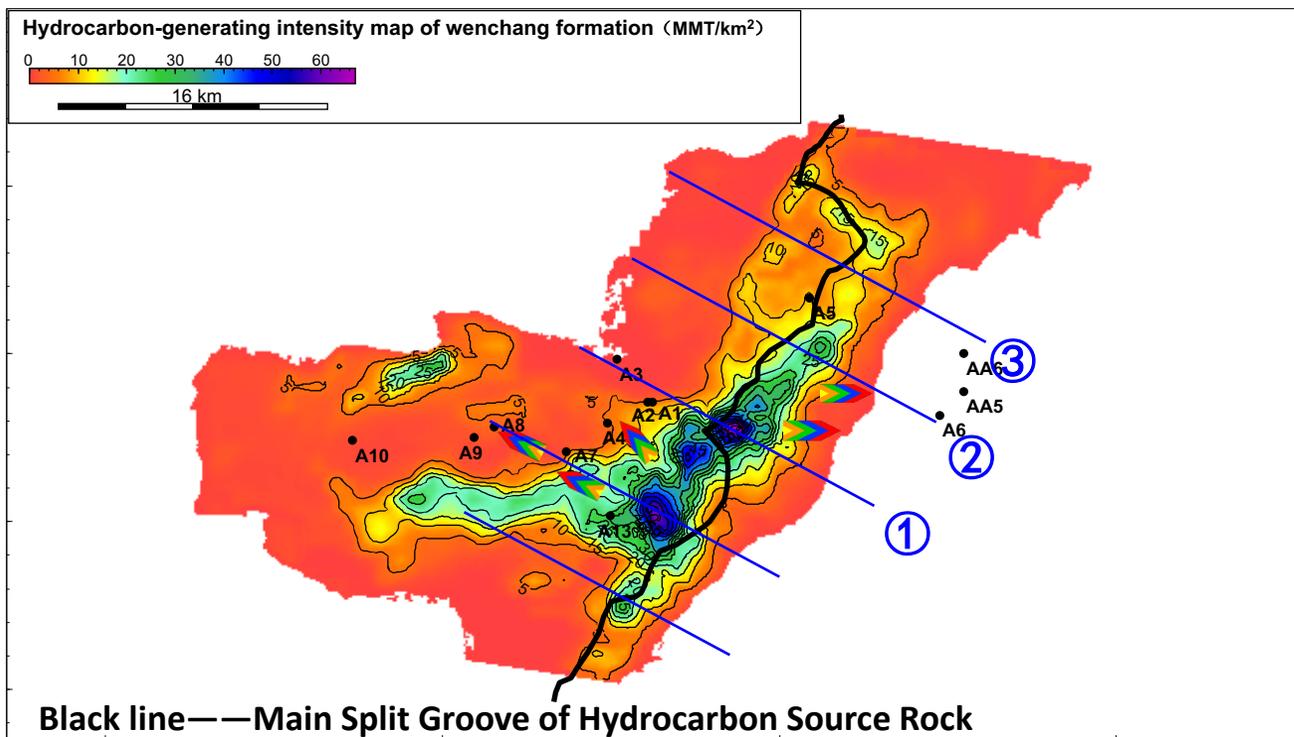
# Content

---

- **Research Background**
- **Key technologies and innovations**
- **Main results of the study**
- **Conclusions and recommendations**



# The First Result: Resource Potential and Main Transportation and Accumulation Direction of B District

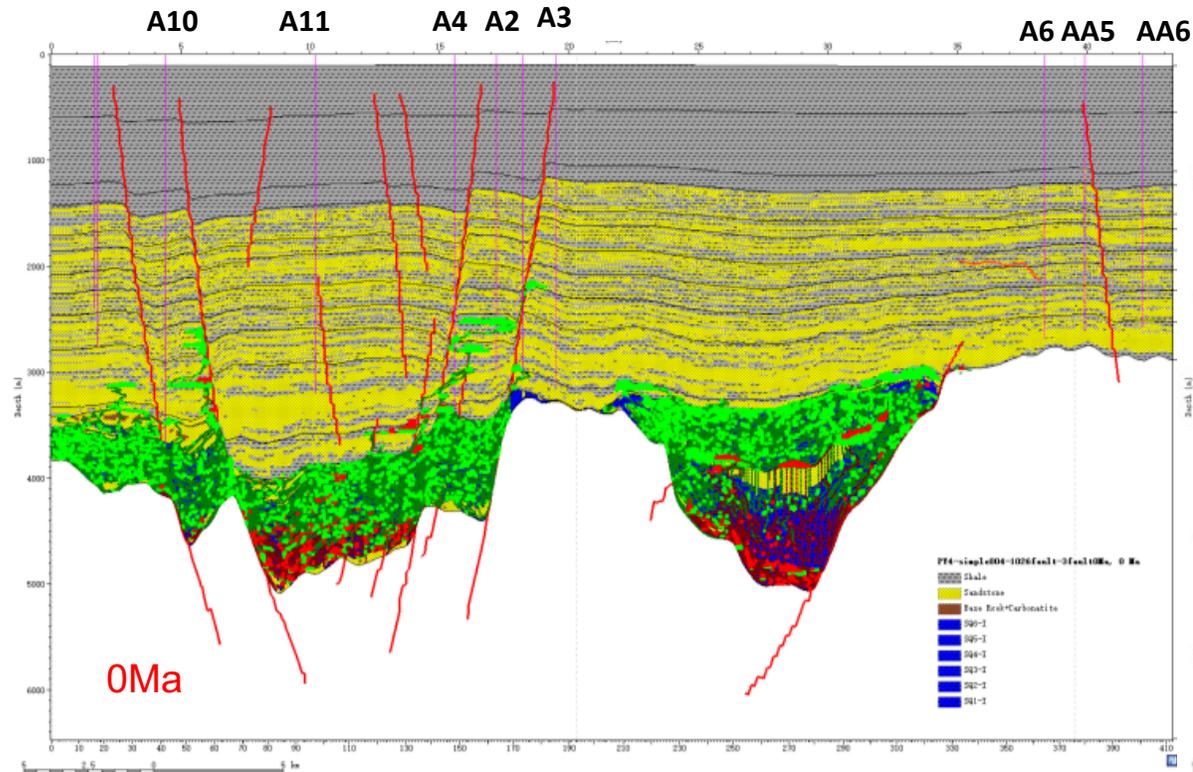


Heterogeneous source rocks directly control the hydrocarbon migration path and distance.

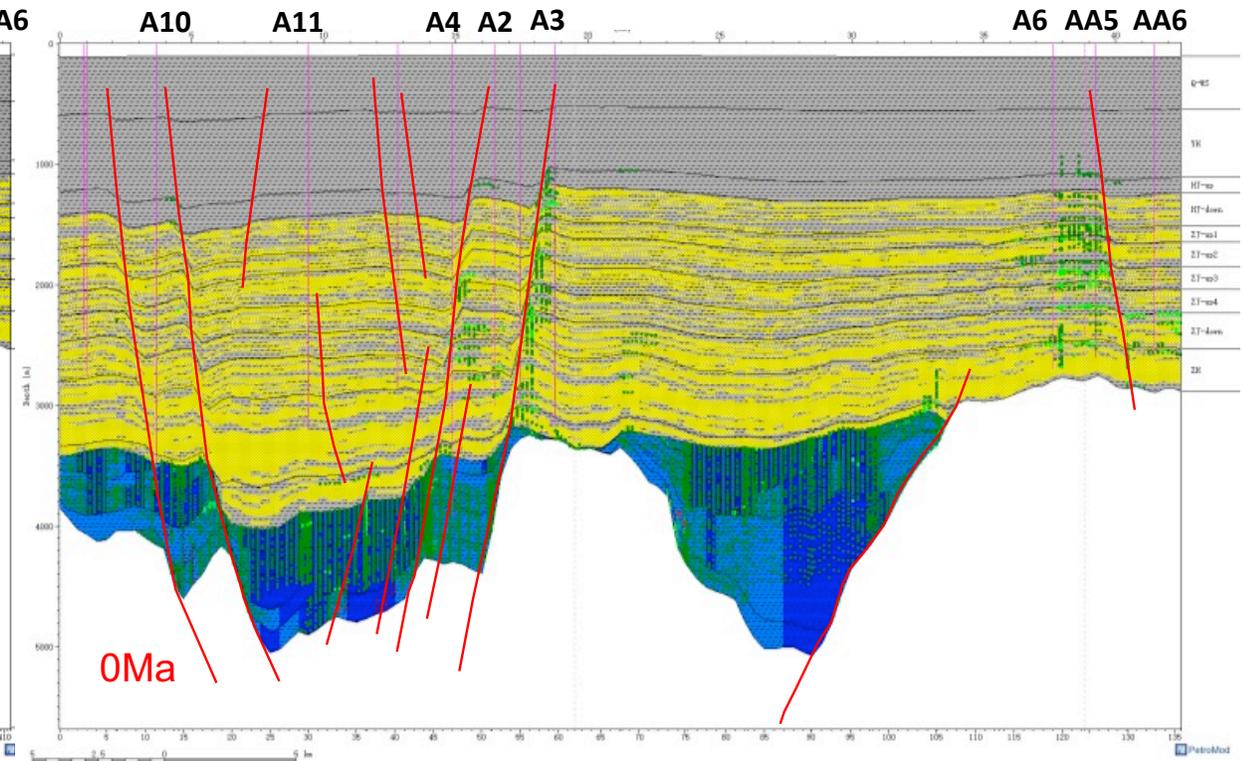


# The Second Result: Hydrocarbon Migration and Accumulation Analysis

## Two-dimensional migration and accumulation simulation



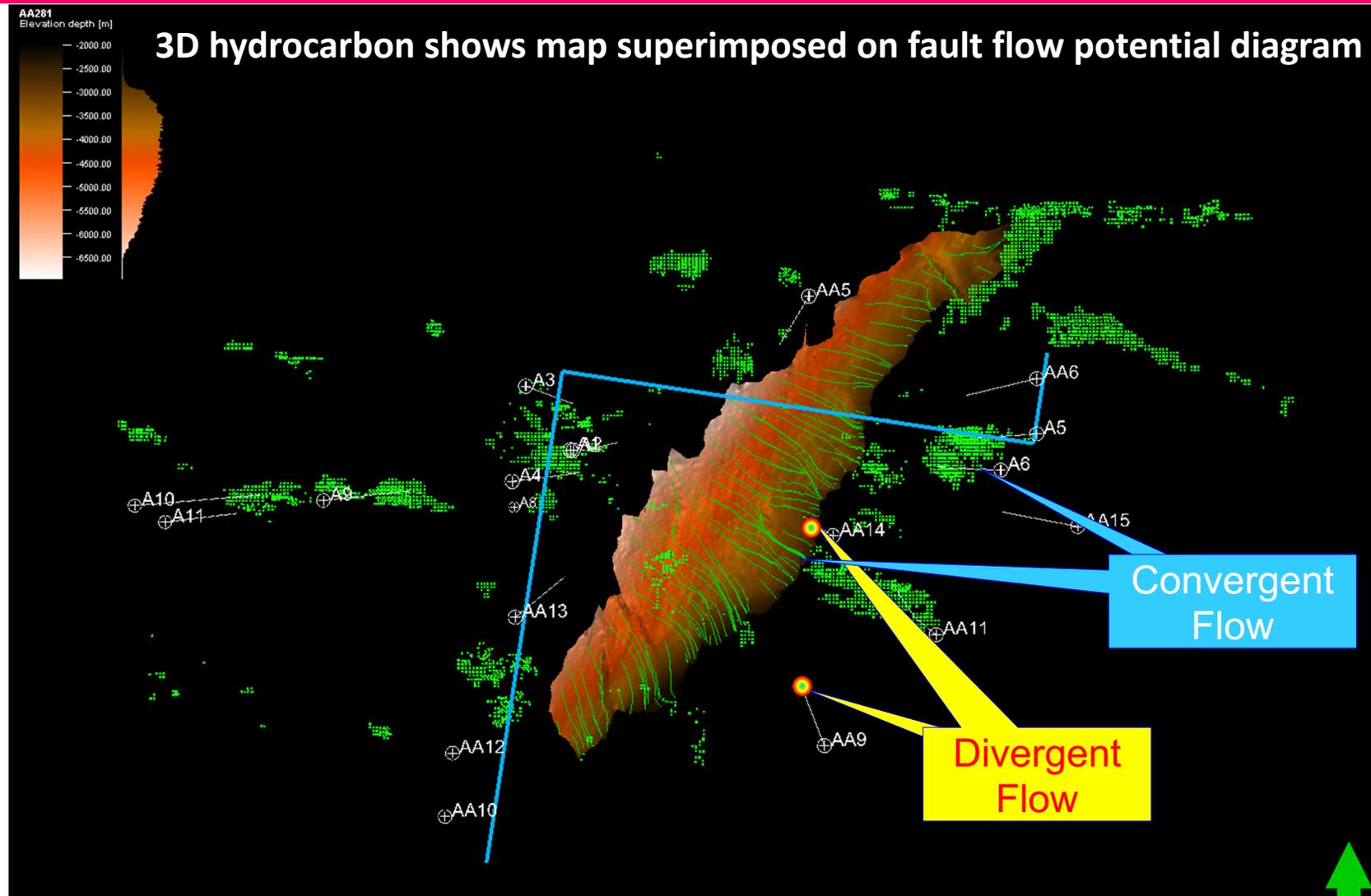
## Three-dimensional migration and accumulation simulation



- ❑ The simulation results of 2D and 3D hydrocarbon migration and accumulation are quite different, under the same geological conditions in the same section.
- ❑ Actual hydrocarbon shows confirmed the simulation results of 3D hydrocarbon migration and accumulation have higher coincidence rate.



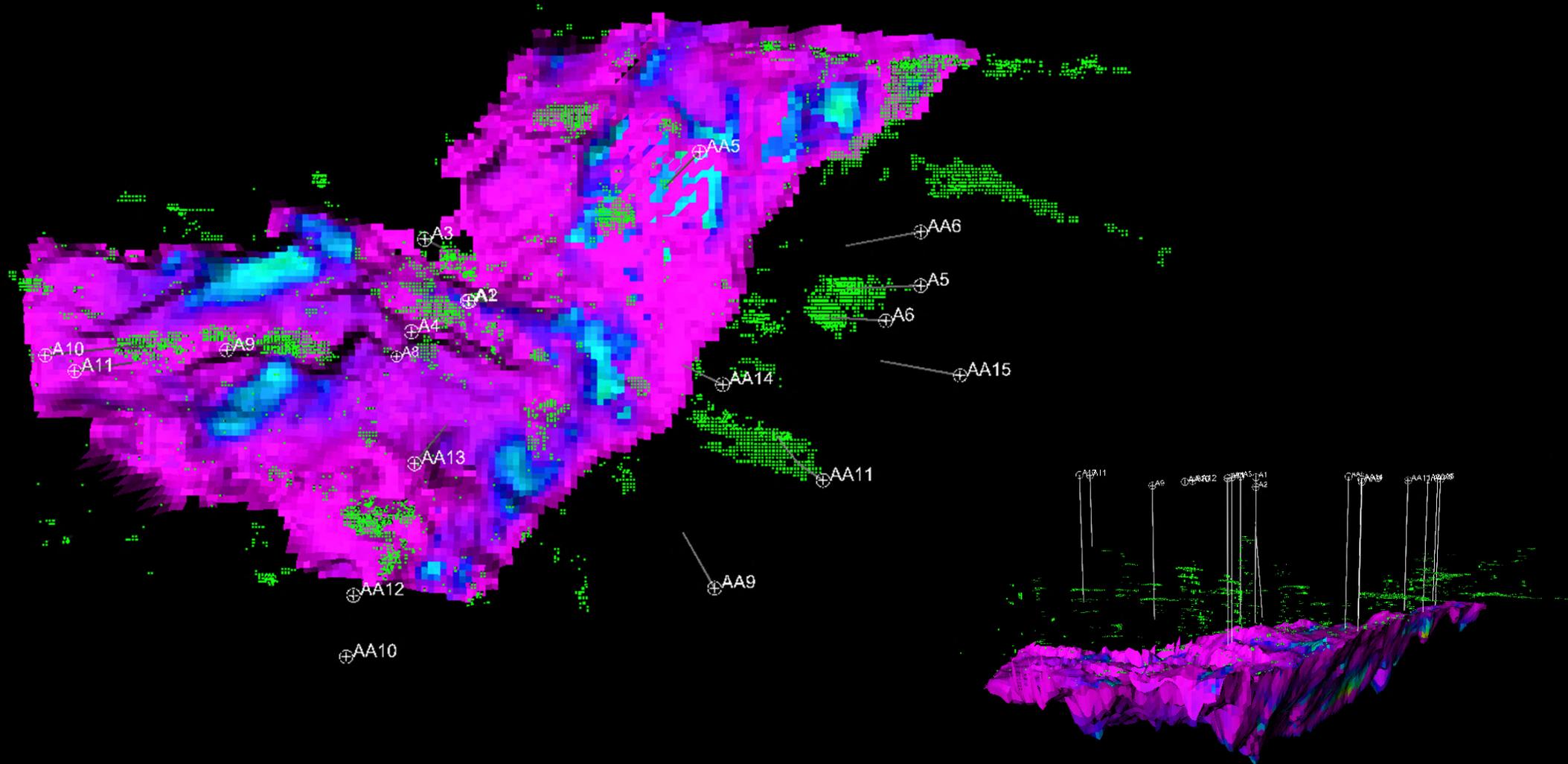
## 2.1 Fault Morphology Controls Hydrocarbon Migration and Accumulation in B district



Through 3D hydrocarbon migration and accumulation simulation , it is found that hydrocarbon migration and accumulation should be controlled by fault morphology and sand body distribution.

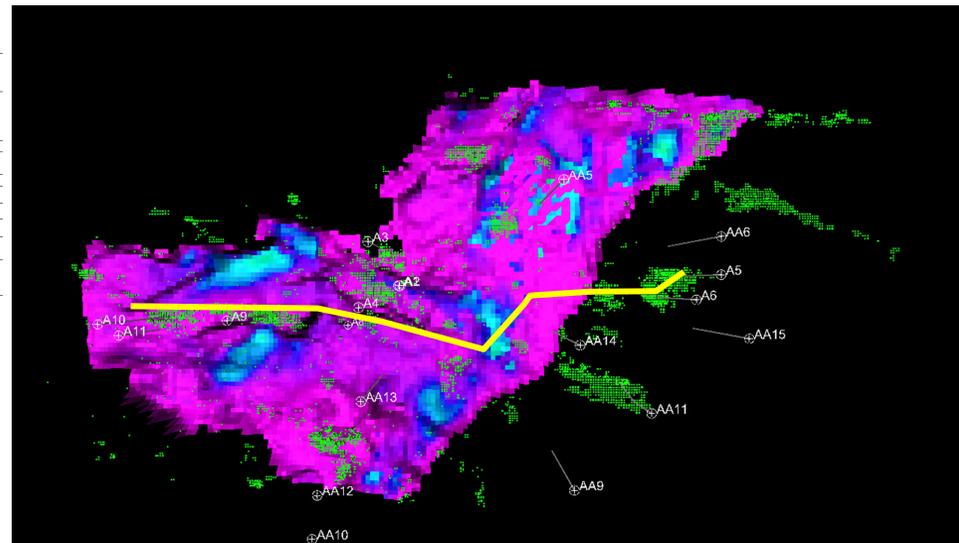
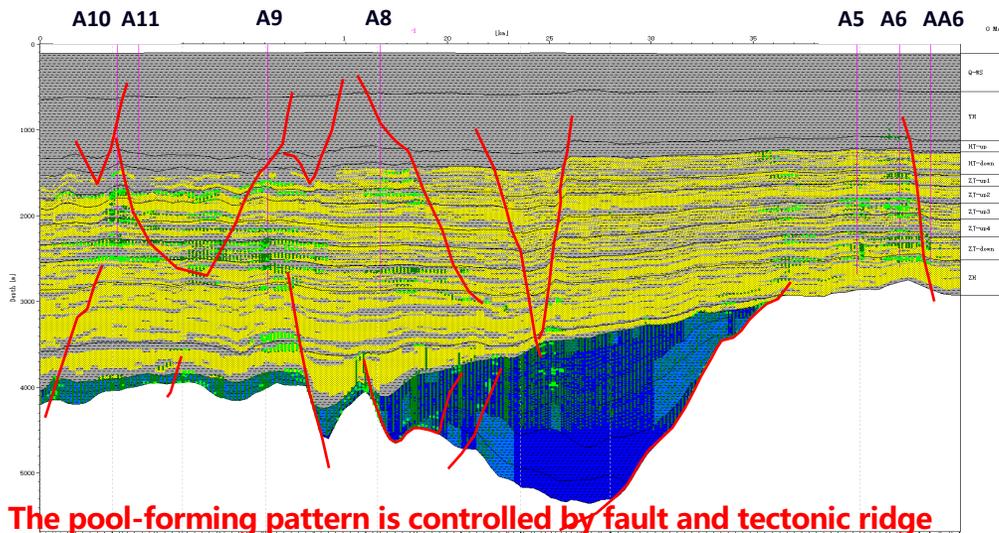
The simulation results of three-dimensional hydrocarbon migration and accumulation are in good agreement with the results of actual drilling .

**The coincidence rate is about 80%**

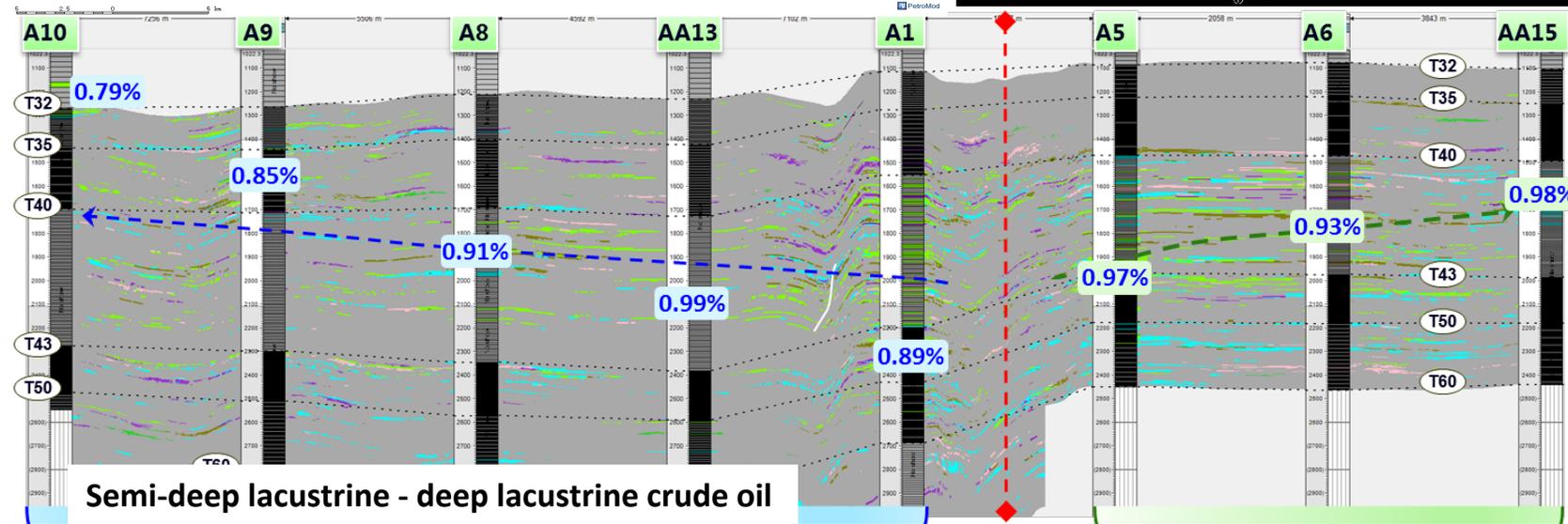




# 2.2 Comprehensive Evaluation of Oil and Gas Three-dimensional Migration and Transportation in B District



The pool-forming pattern is controlled by fault and tectonic ridge



Semi-deep lacustrine - deep lacustrine crude oil

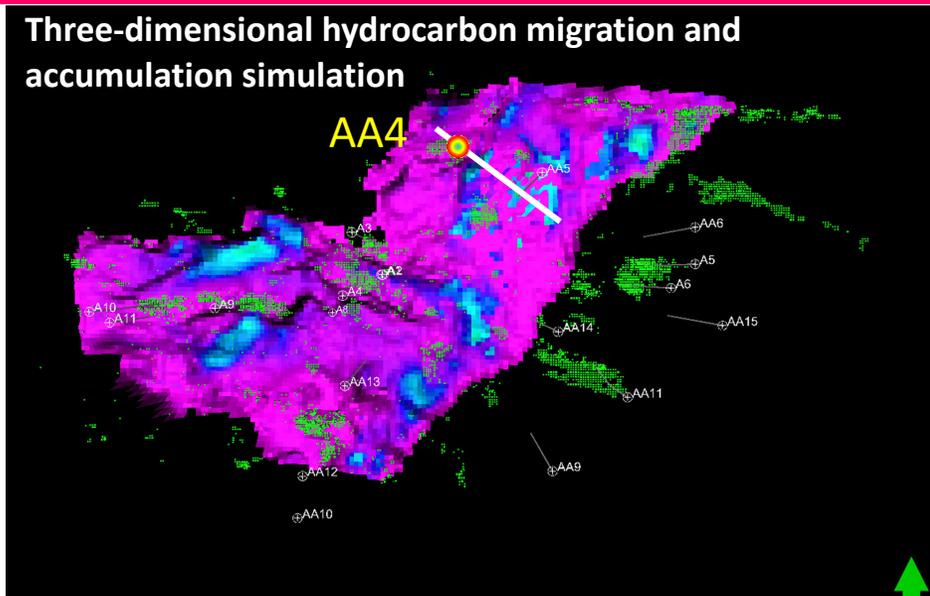
Oil from the third formation of Wenchang gathers in the west T32-T43 of B district

Oil from the fourth formation of Wenchang gathers in the east T40-T60 of B district

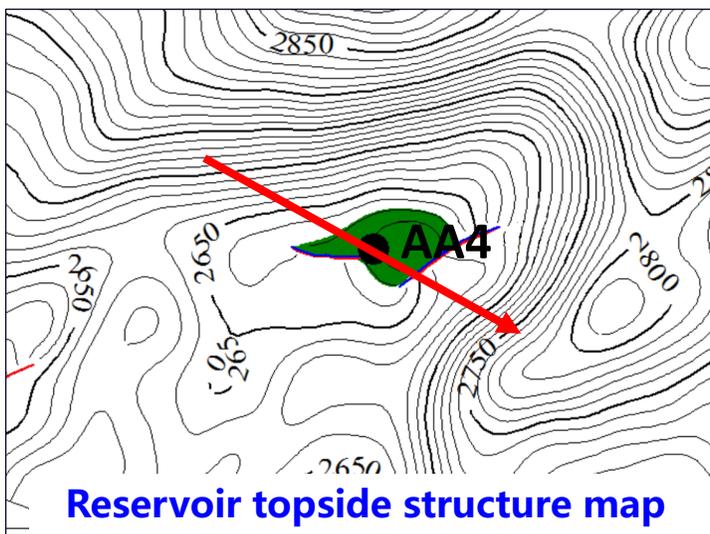


# The Third Result: Application Effect

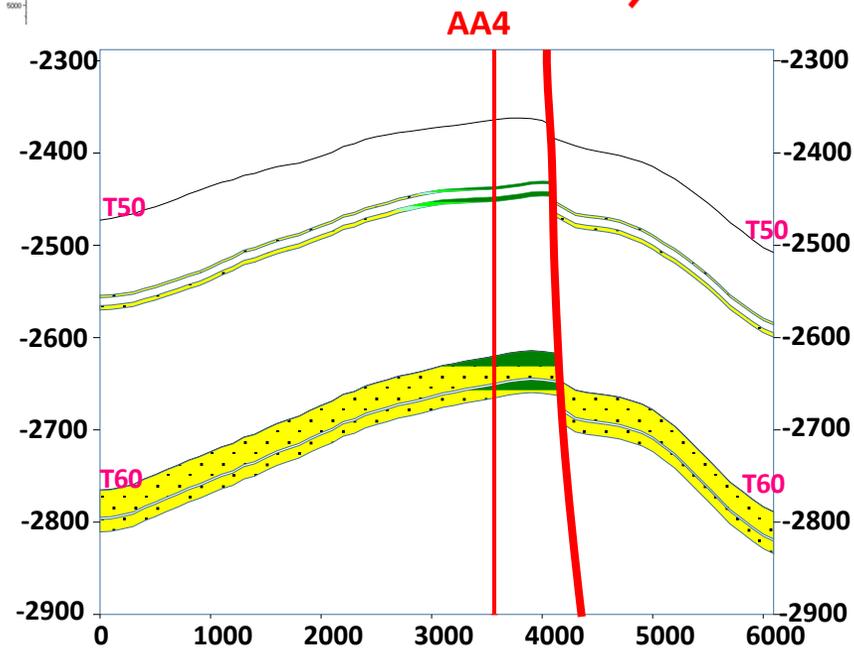
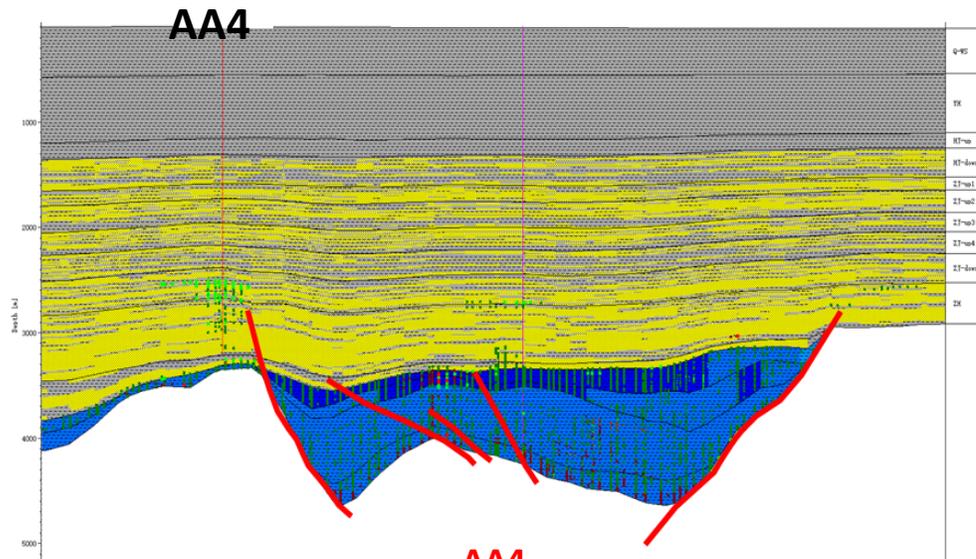
Three-dimensional hydrocarbon migration and accumulation simulation



A potential commercial oil field AA4 was discovered in B district



Reservoir topside structure map





# Content

- **Research Background**
- **Key technologies and innovations**
- **Main results of the study**
- **Conclusions and recommendations**



# Conclusions and Recommendations

## ➤ Conclusions

Based on Petromod and Petrel, the quantitative study of the four-dimensional spatio-temporal coupling relationship between **static elements** (such as generation, storage, capping) and **dynamic elements** (such as generation, migration, trap formation, accumulation and dispersion) of hydrocarbon accumulation in petroleum system has been realized firstly, providing effective basis for the prediction of favorable hydrocarbon accumulation zones and targets.

## ➤ Recommendations

- I. For **high precision sand body modeling**, the finer the modeling, the slower the software;
- II. During **fault attribute modeling**, fault properties can be analyzed qualitatively and quantitatively, but it is impossible to **predict the efficiency of fault transportation** in geological history dynamically.

A vibrant sunset over the ocean. The sun is a bright, glowing orb on the horizon, casting a long, shimmering reflection across the water. The sky transitions from a deep blue at the top to a warm orange and yellow near the horizon. In the foreground, waves with white foam are crashing onto a dark, rocky beach. The overall scene is peaceful and beautiful.

*Thank you*

*Please comment and correct*