The Characteristics and Prospect of Giant Oil and Gas Fields in Marine Carbonate Sequence in China*

Jin Zhijun[1]

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Abstract

The recent discoveries of the Puguang gas field in the Sichuan basin, southwestern part of China and the Tahe oil field in the Tarim basin, northwestern part of China indicates the great hydrocarbon potential of the marine carbonate sequence in China. The most promising exploitation and exploration prospects are the Ordos, the Tarim, and the Sichuan basins and adjacent regions. The characteristics of the giant oil and gas fields in marine carbonate sequences in China are as follows:

1. Under the Paleozoic extension scenario, the sediments developed in the cratonic basins, rifting basins and margins in the North China, the Yangtze and the Tarim blocks, have provided good source rocks for hydrocarbon generation;

2. The paleo-uplifts and marginal slopes of the cratonic basins are enriched hydrocarbon zones. They are favorable traps for hydrocarbon accumulation. These types of oil and gas fields have been found in the Sichuan, the Ordos, and the Tarim basins;

3. Reef, shoal sediments and pore-vuggy-fractured carbonate sequences are favorable reservoirs in marine carbonate sequences. The 480m Ordovician karstic carbonate sequence is the major reservoir in the Tahe oil field in the Tarim basin, in addition the 329m Triassic vuggy dolomite provides good reservoir in the Puguang gas field, in the Sichuan basin;

4. Thick dark mudstone, shale and evaporates formed good seals and caprocks for hydrocarbon preservation, i.e. the Mid-Lower Triassic evaporates in the Puguang gas field and the Carboniferous evaporate-mudstone in the Tahe oil field are very effective seals.

5. In the Tahe oil field, the plays were formed in multiple phases. Some of them were formed in early-Hercynian time, late-Hercynian time and Indosinian-early-Yanshanian time, and the major play was formed in the late-Yanshanian time and Himalayan time. In the Puguang gas field, the gas play was formed during the Himalayan orogeny.

AAPG International Conference

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Cape Town

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African Energy Global Impact

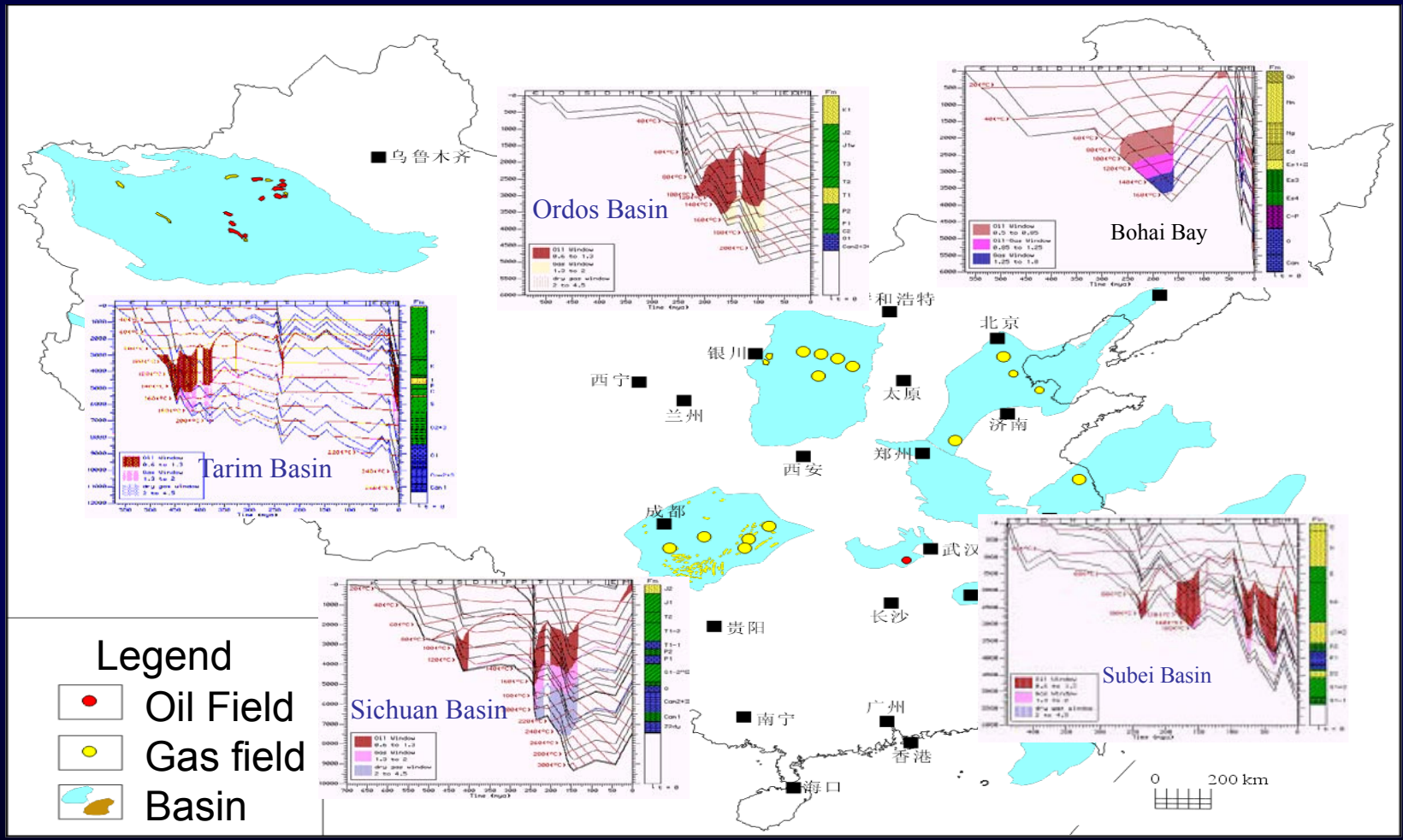
Outline

1. The characteristics of giant oil and gas fields in marine sequences

2. Forecast of oil and gas distribution in marine sequences in China

1. The characteristics of giant oil and gas fields in marine sequences

1.1 Development of multiple source rock intervals with multiple episodes of petroleum generation and expulsion

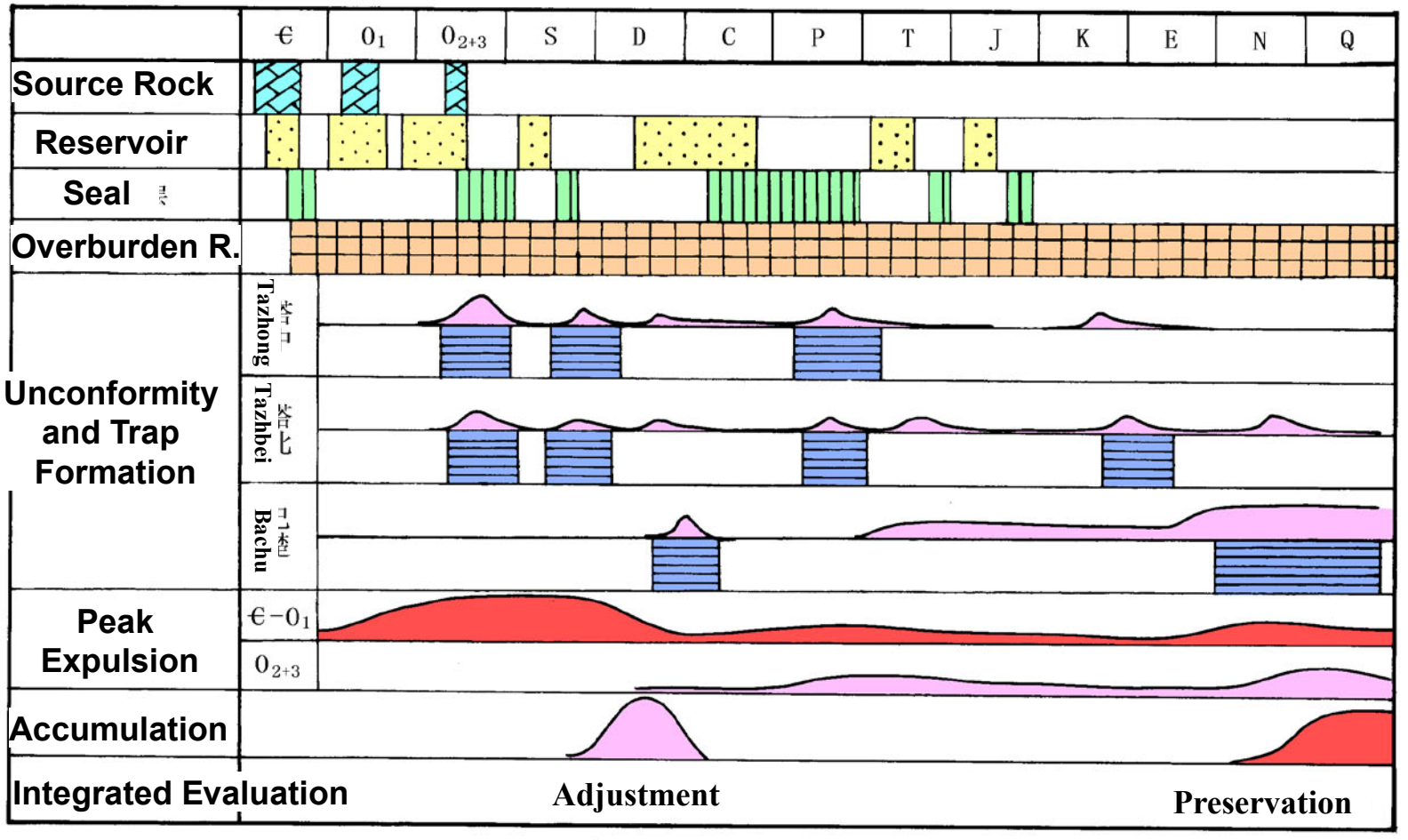


1. The characteristics of giant oil and gas fields in marine sequences

1.1 Multiple source intervals

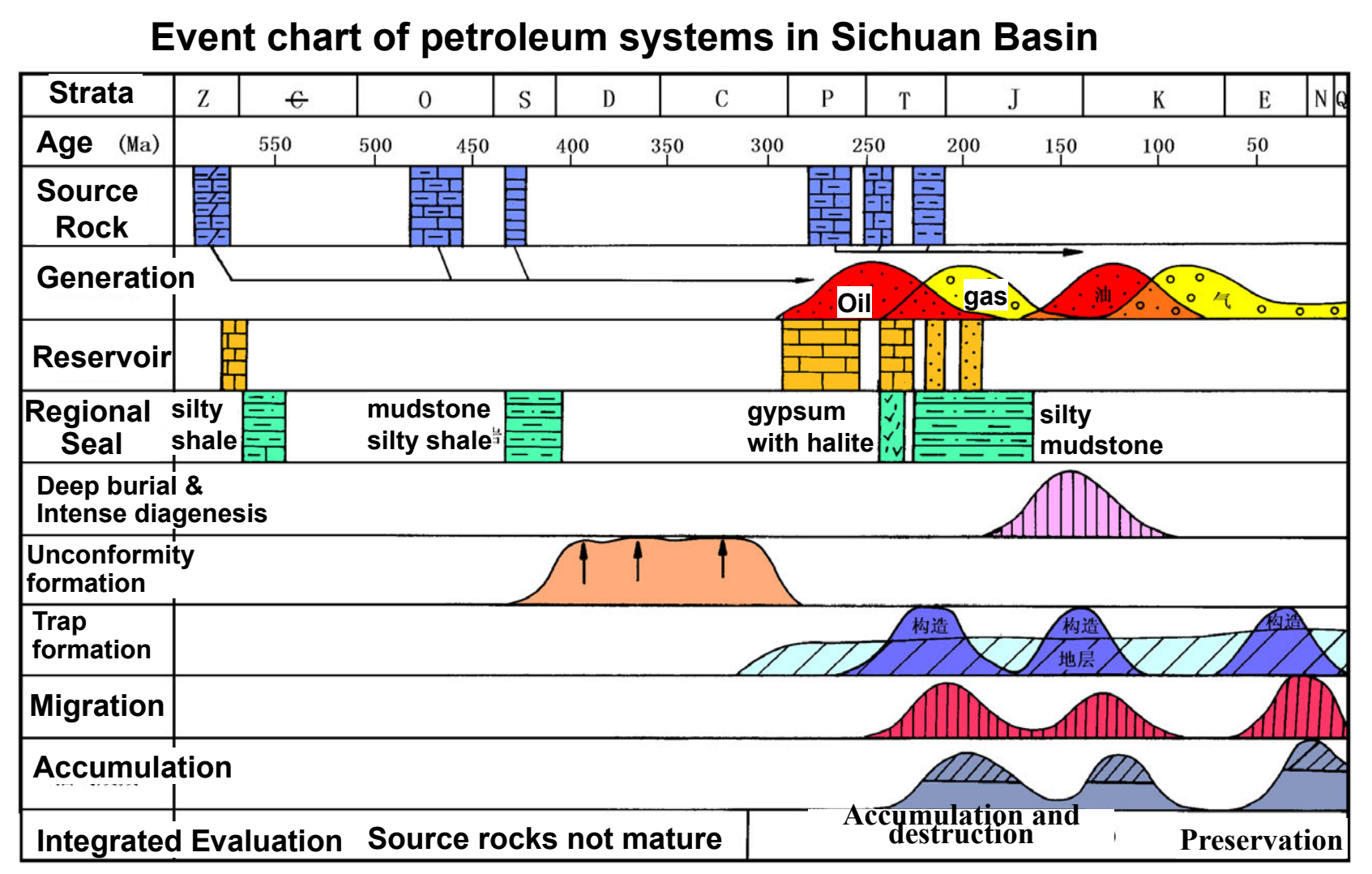
Geological processes are characterized by multiple episodes of generation and accumulation with subsequent readjustment

Due to low geothermal gradients and short period of deep burial, liquid hydrocarbons could be preserved in Tazhong and Tabei areas.

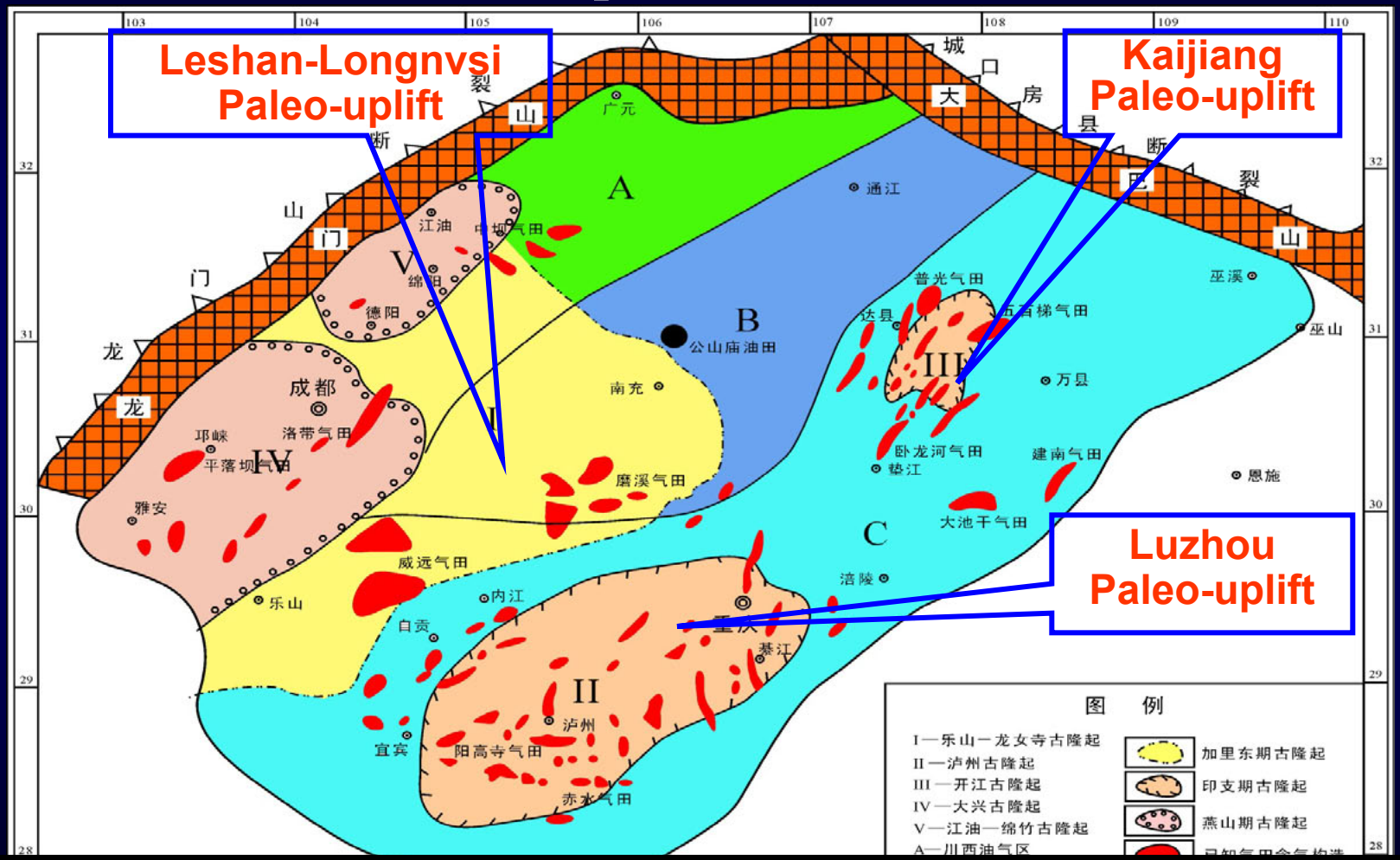


Event chart of Cambrian and Ordovician petroleum systems in platform areas of Tarim Basin

1.1 Multiple source intervals



1.2 Paleo-high and paleo-slope controlled earlier HC accumulation and late entrapment.

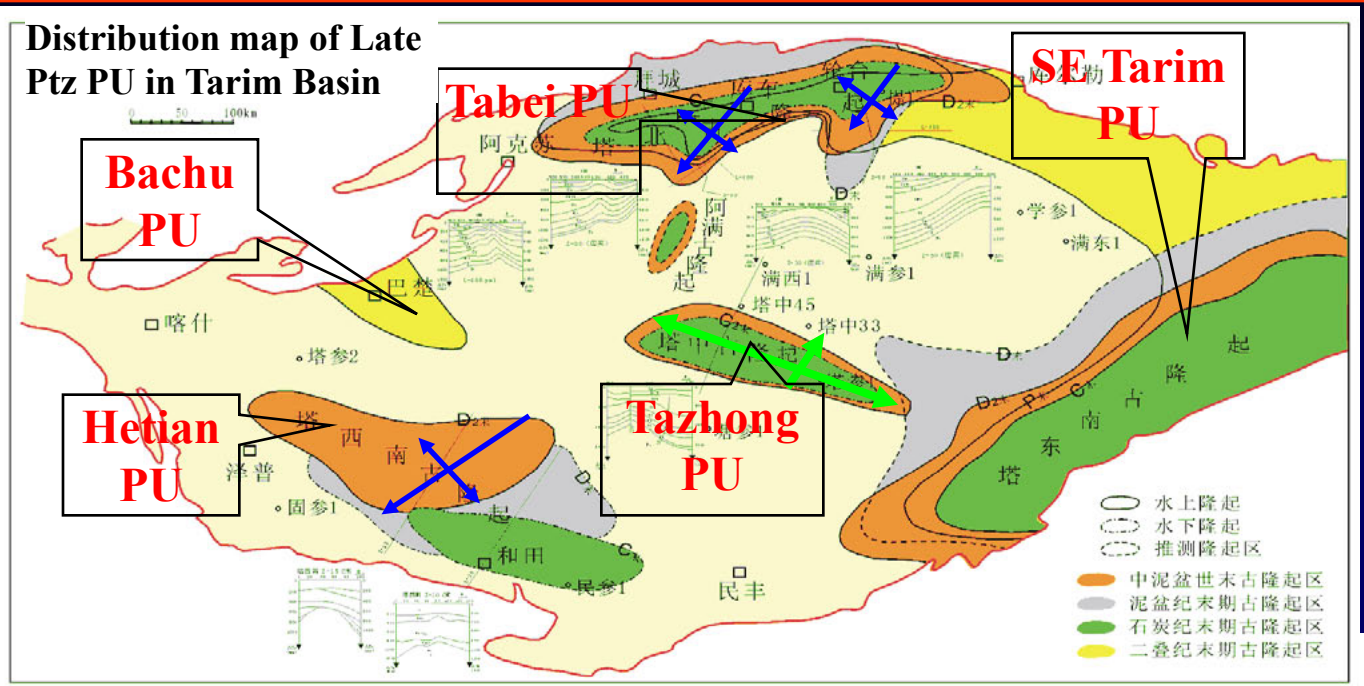


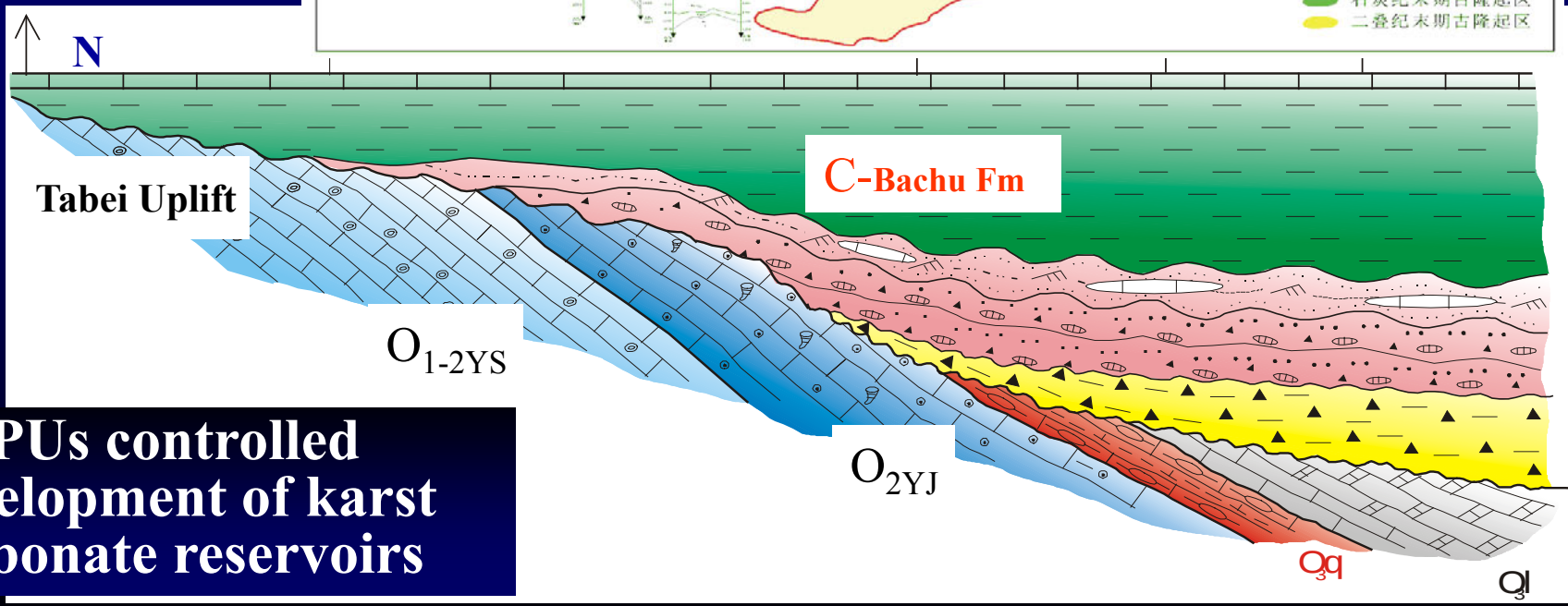
Caledonian Leshan-Longnvsi PU controlled gas accumulation in Sinian-Ordovician successions while Indosinian Kaijiang and Luzhou PUs had a significant control on gas accumulation in C-Tr2 sequences.

1. The characteristics of giant oil and gas fields in marine sequences

1.2 Paleo-high and paleo-slope

(1) PUs were catchment areas of migrating petroleum

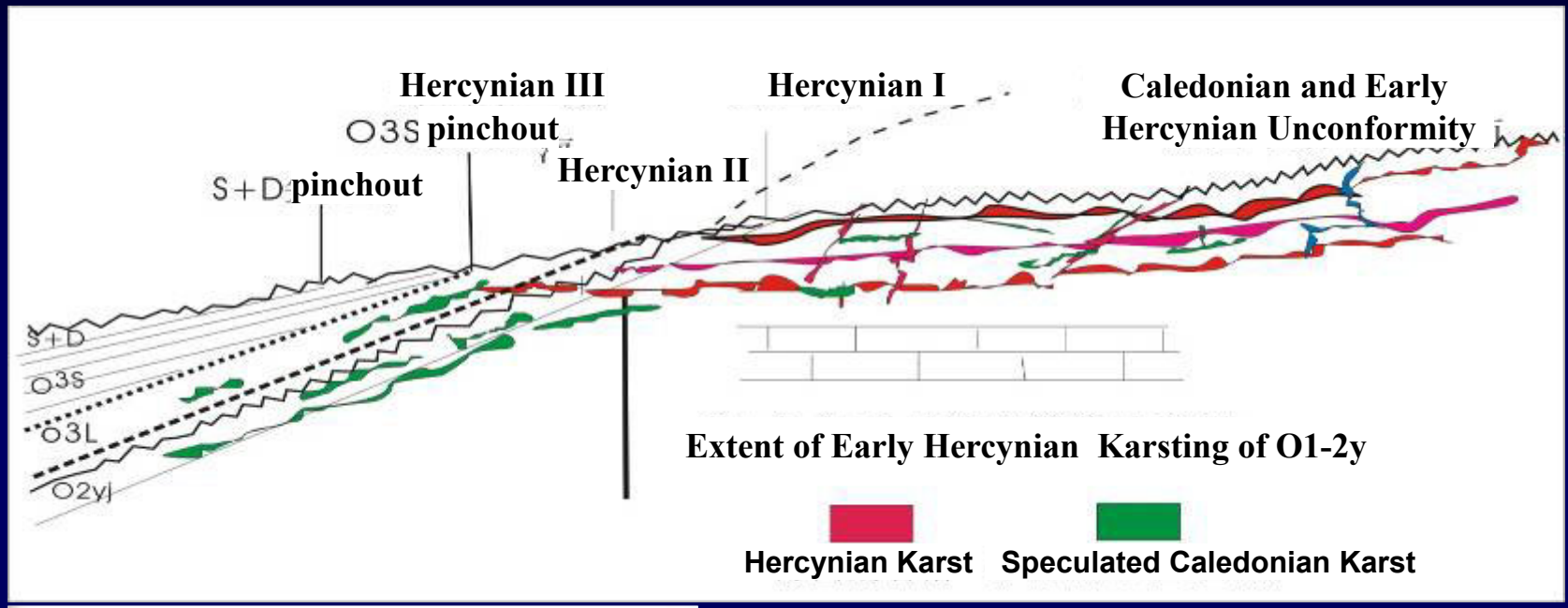


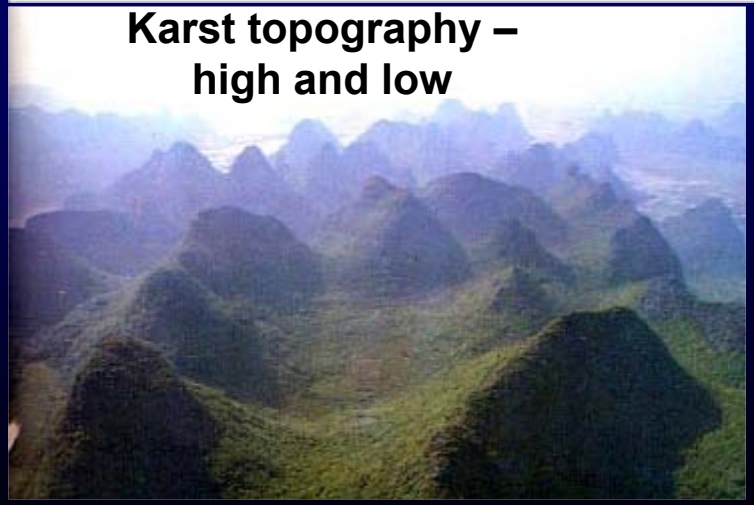


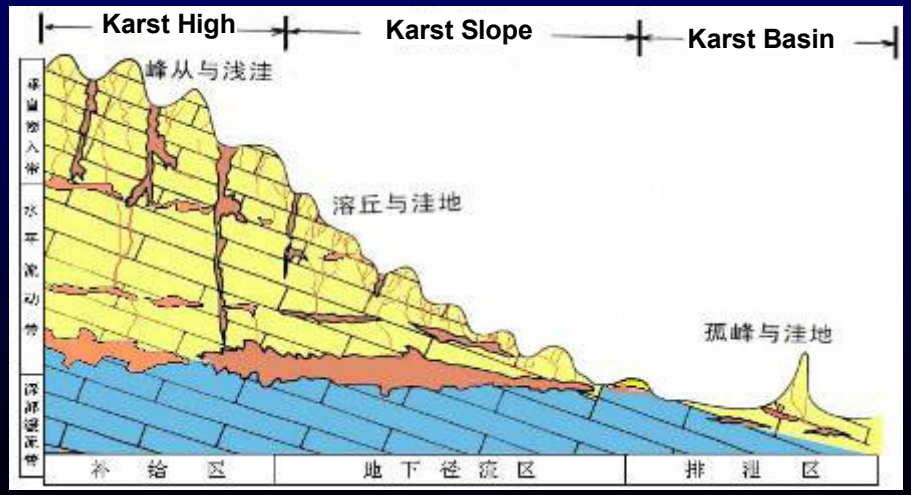
(2) PUs controlled development of karst carbonate reservoirs

1. The characteristics of giant oil and gas fields in marine sequences

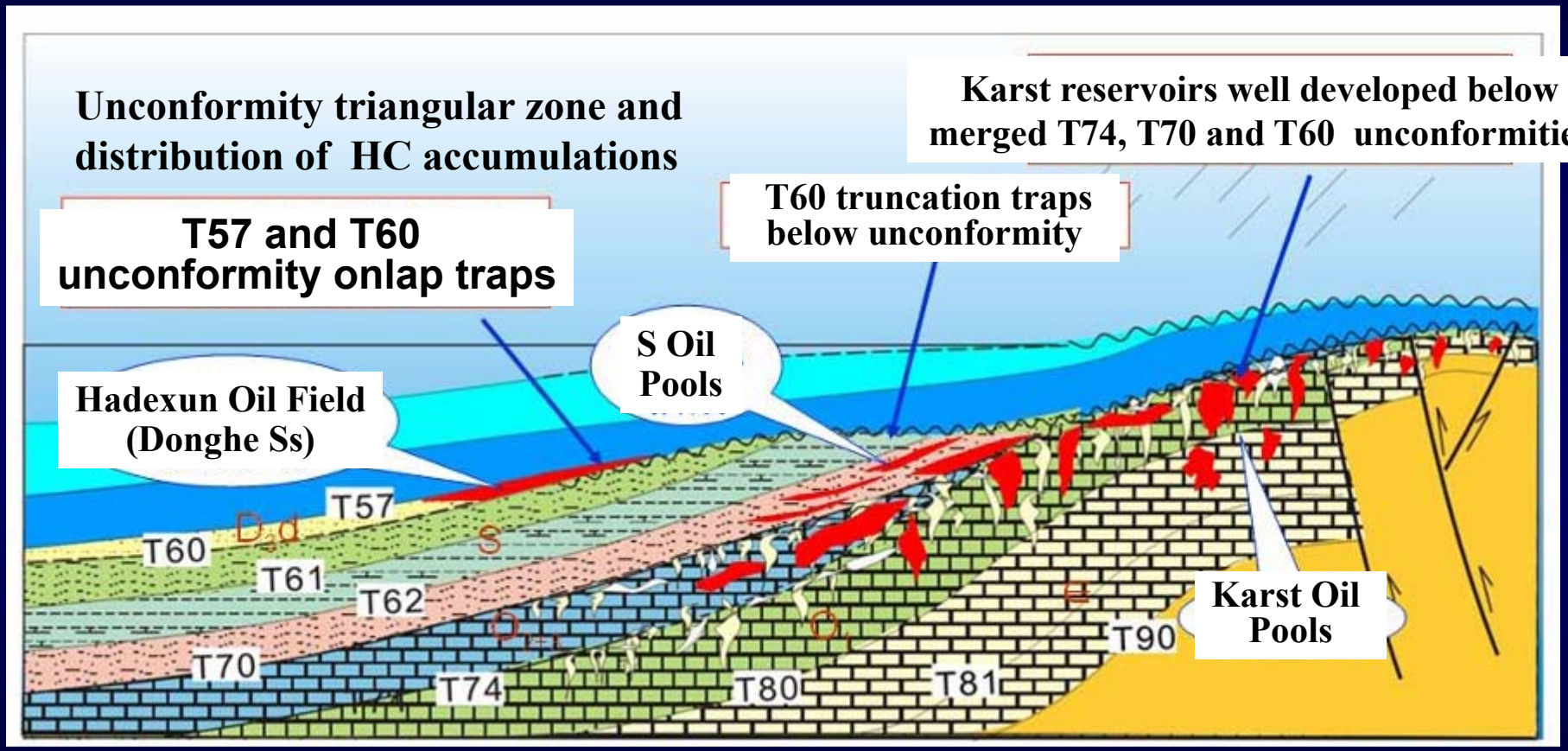
PUs controlled development of karst carbonate reservoirs





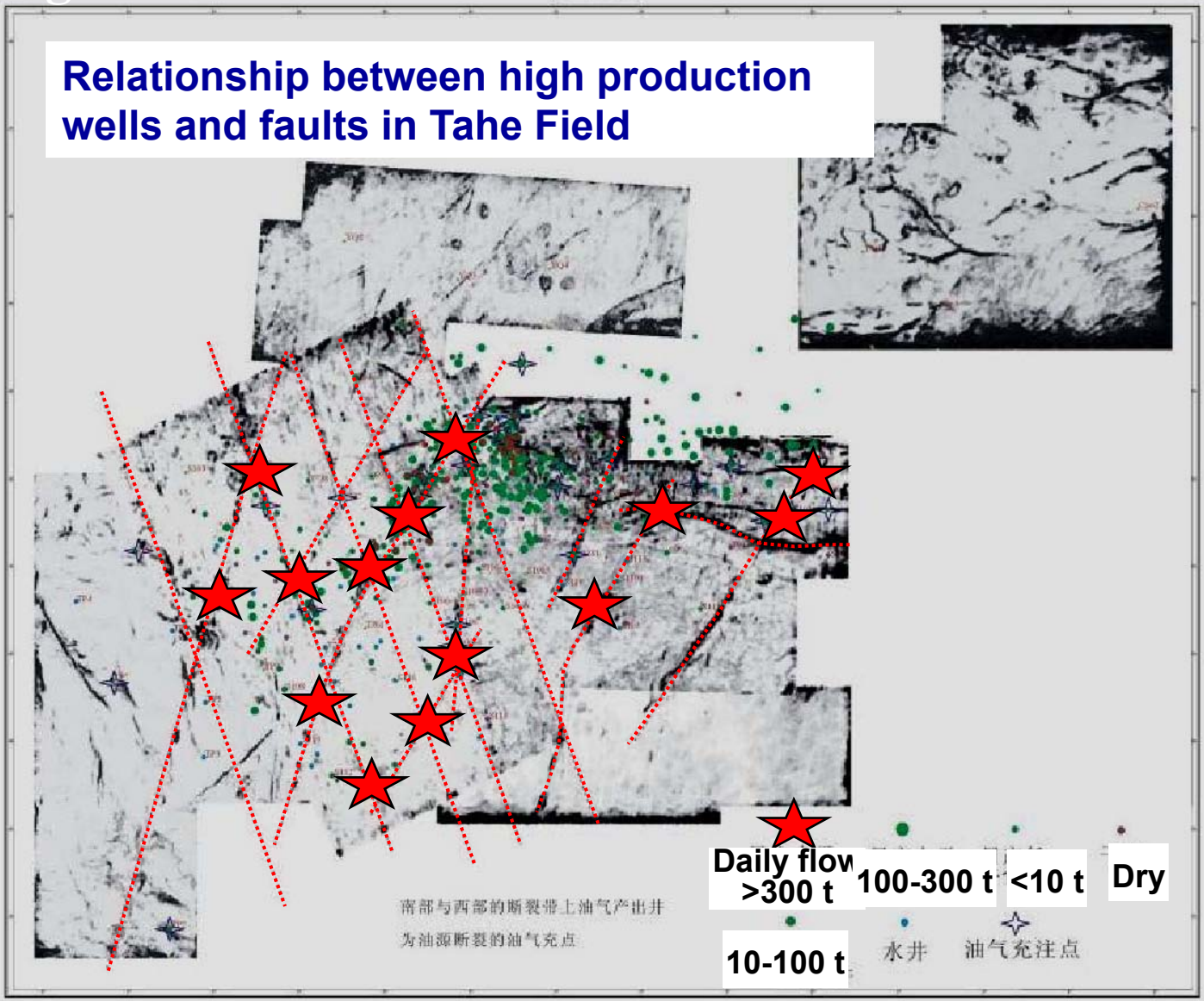


1.2 Paleo-high and paleo-slope



(3) PUs controlled development of multiple types of traps (e.g. unconformity, drape anticline and pinchout).

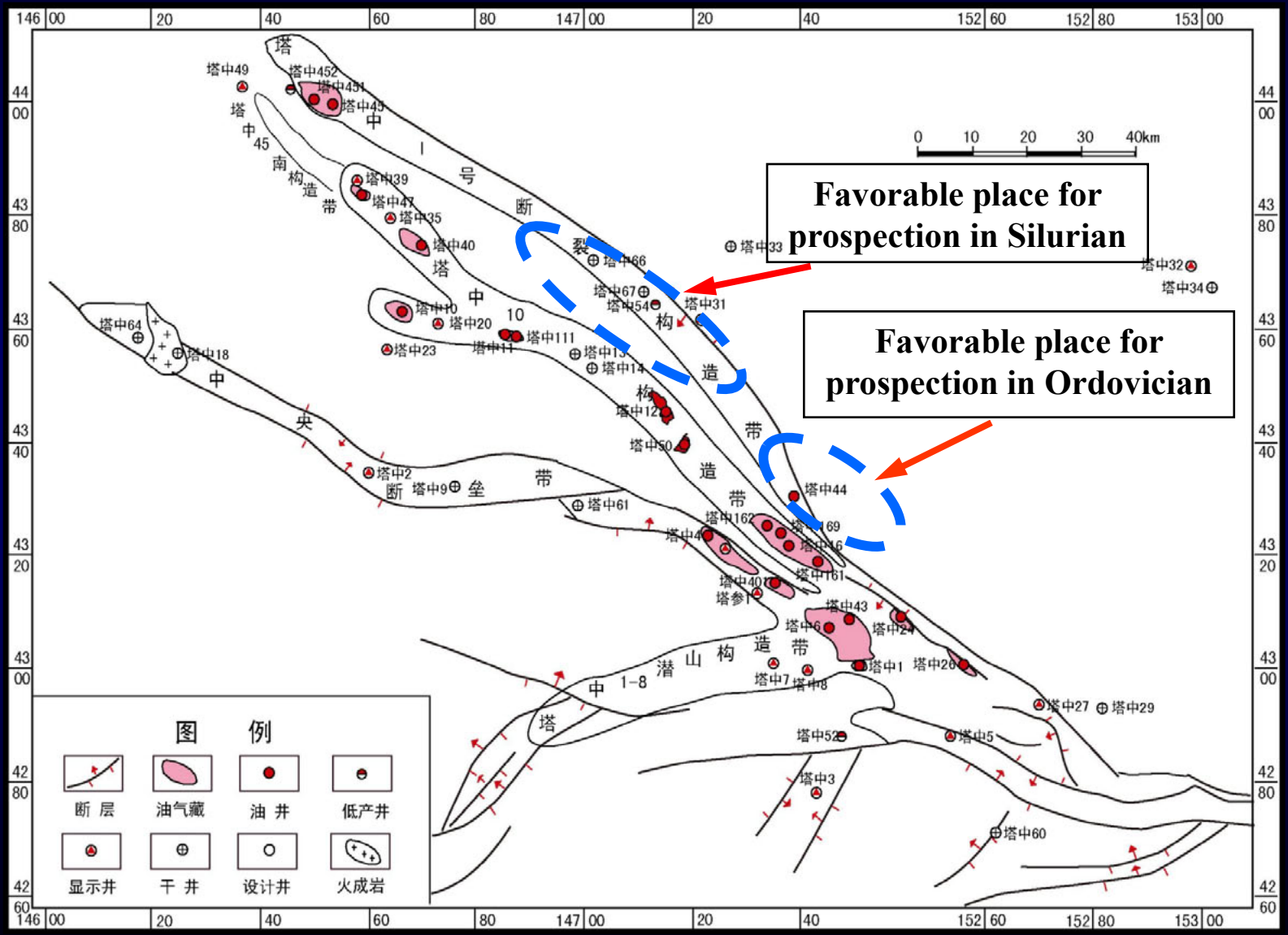
1.3 Large faults and unconformities controlled petroleum migration and accumulation.



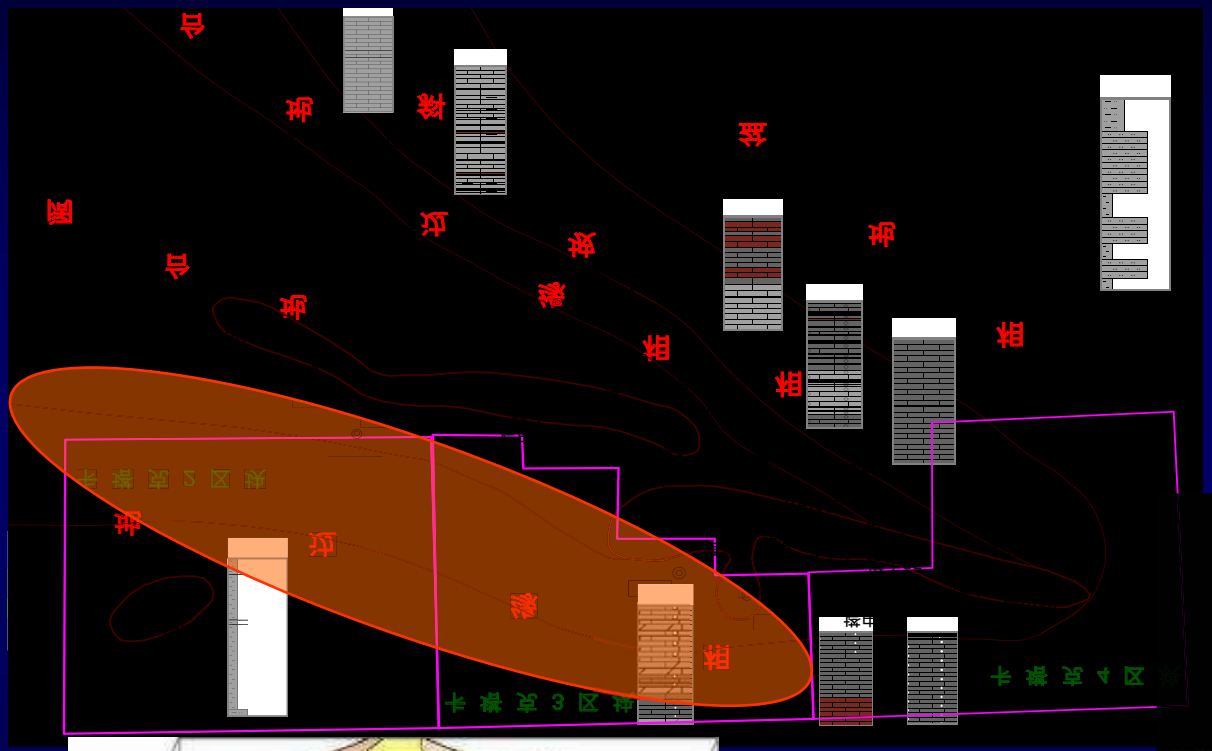
Large faults controlled development of karst reservoirs and they had a significant impact on oil and gas migration.

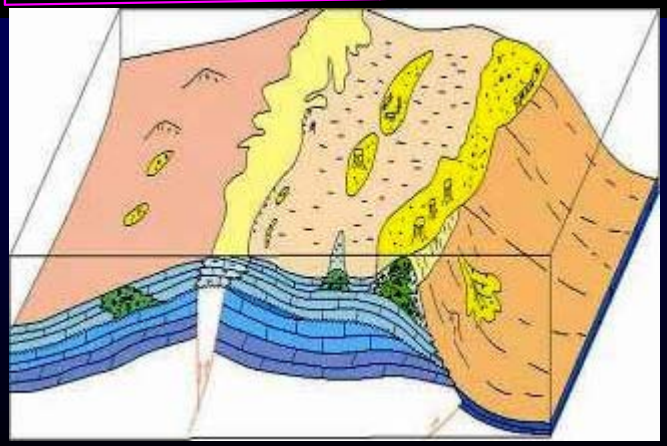
1. The characteristics of giant oil and gas fields in marine sequences

The distribution of oil and gas fields in the center of Tarim basin

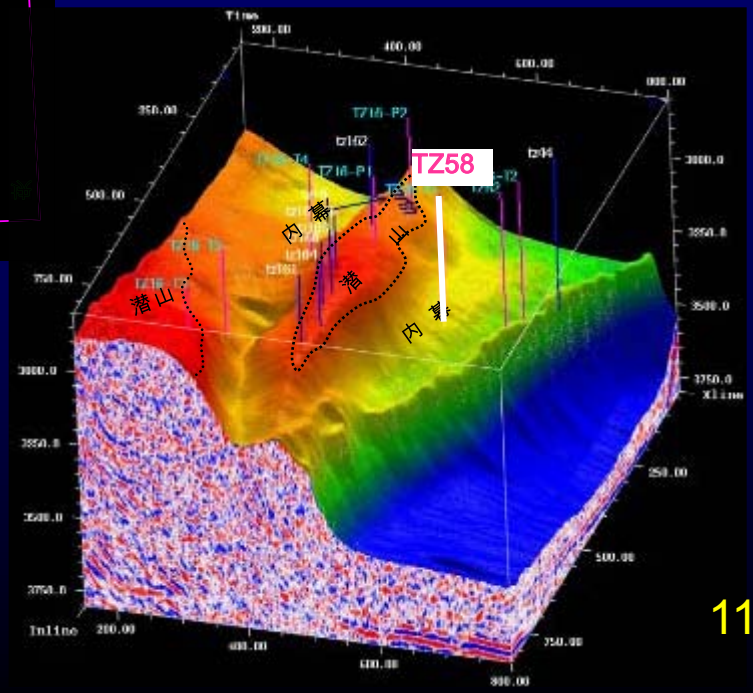


1.3 Large faults and unconformities

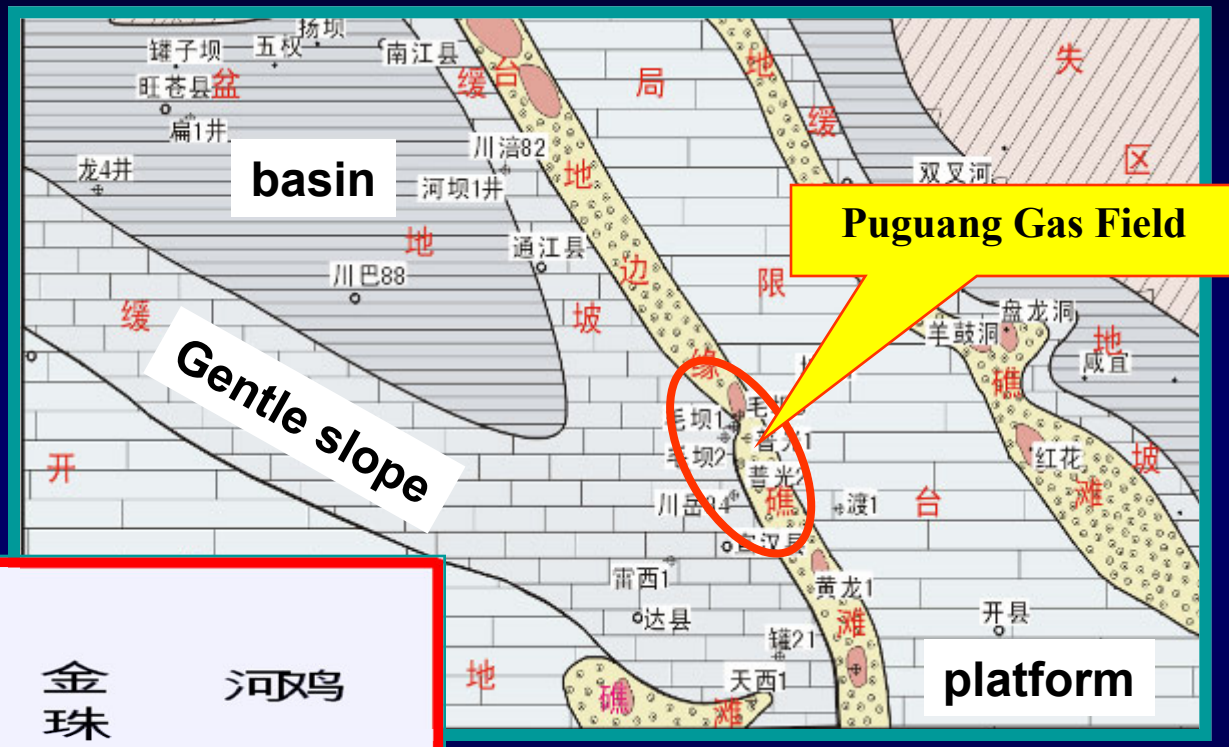




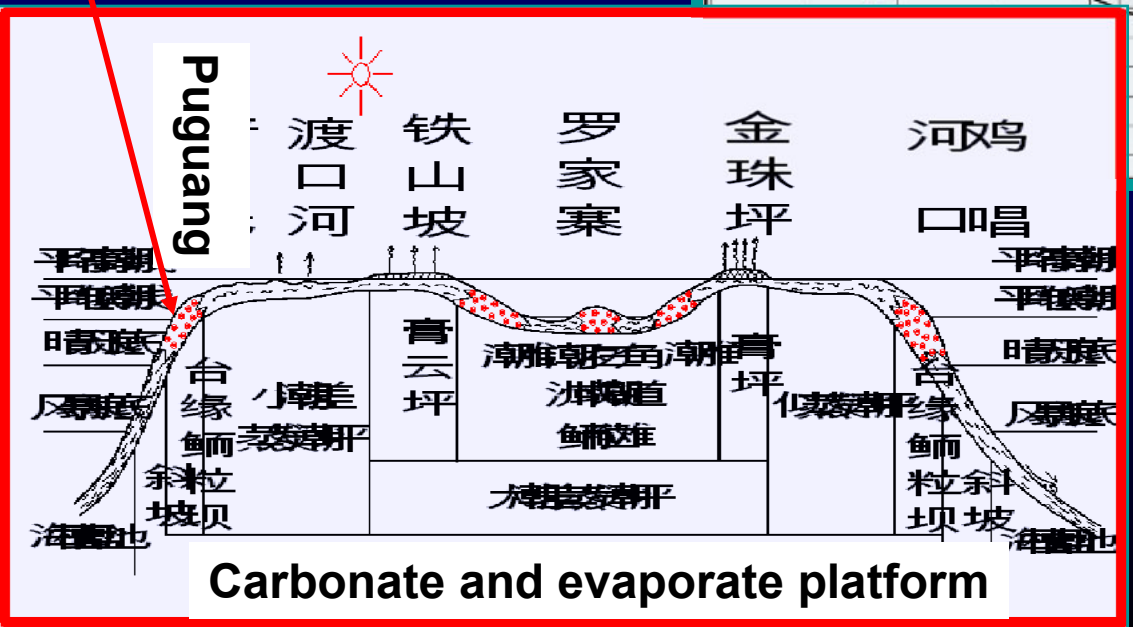
Faults controlled development of reservoirs and they also acted as migration pathways.



1.4 High quality reef and shoal facies on platform margins are favorable areas for HC enrichment.



Platform margin oolite shoals

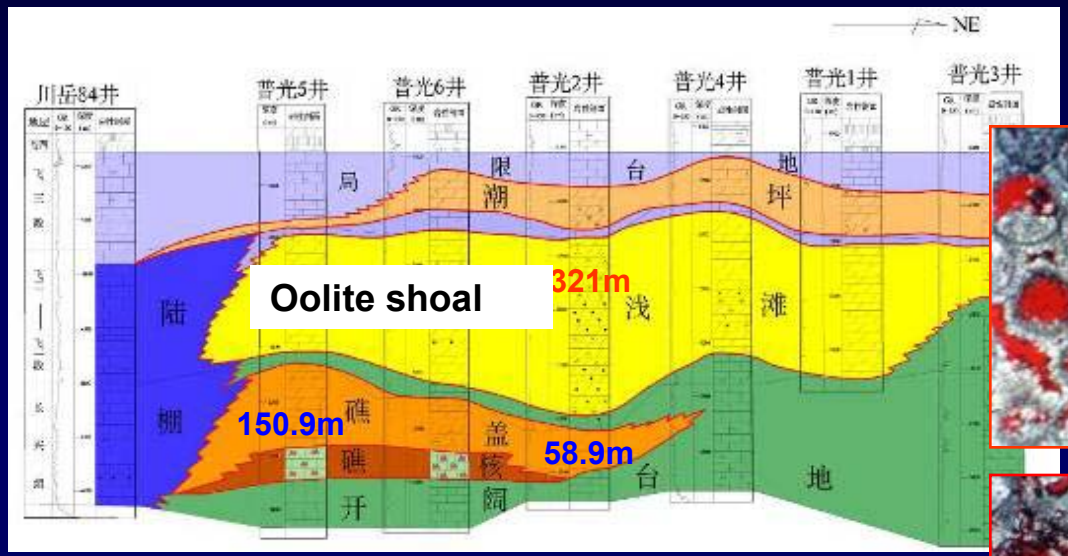


Carbonate and evaporate platform

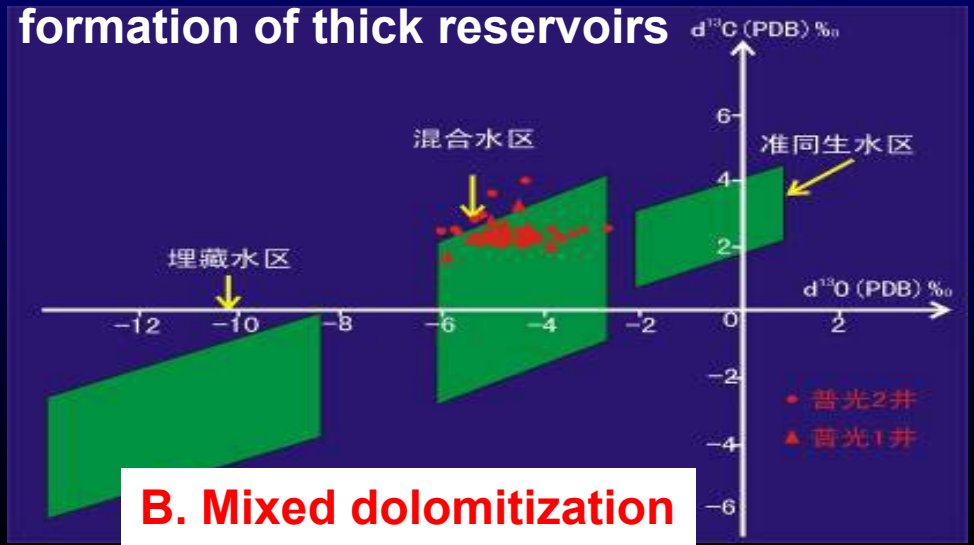
Prediction of high quality reservoirs is very important and it's the key for prospect evaluation. For example, once good reservoirs were found, discovery could be made for the upper play in NE Sichuan Basin.

1.4 High quality reservoirs

Dolomitized shoal oolite reservoirs in Puguang Field



A. superposition of shoal facies led to formation of thick reservoirs

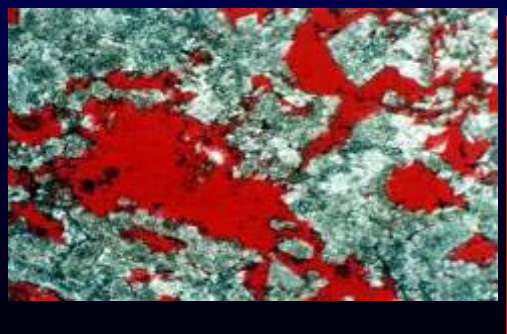


B. Mixed dolomitization

C. 3 episodes of dissolution

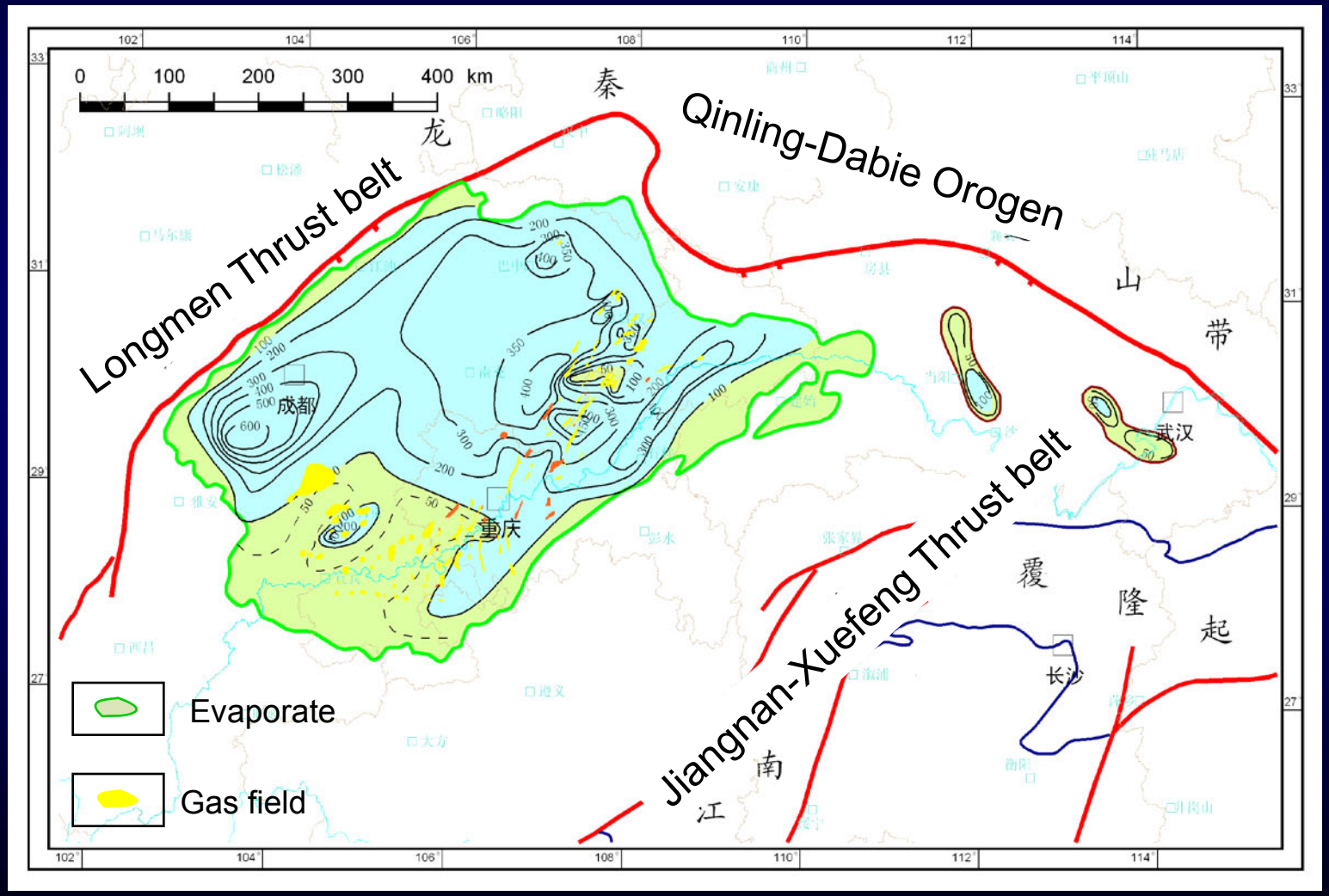
1st: formation of moldic and intra-oolite porosity, partly filled with calcite and dolomite

2nd: non-selective dissolution in deep burial diagenetic setting, formation of dissolution porosity, filled with bitumen



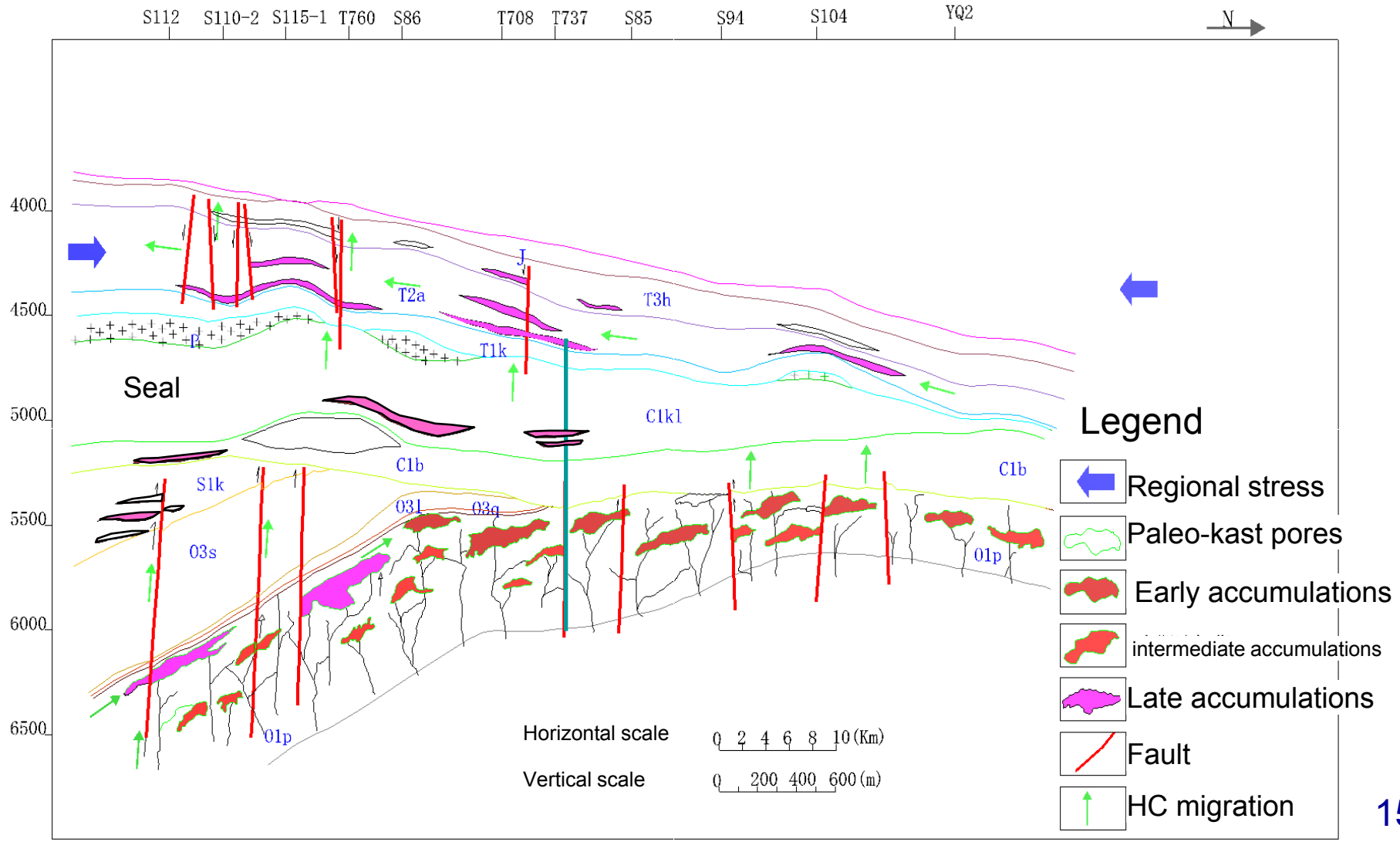
3rd: porosity formed by non-selective dissolution in late deep burial prior to gas charging, most unfilled and thus provide pore spaces for gas to accumulate

1.5 Effectiveness of preservation conditions is the key for the formation and preservation of significant oil and gas accumulations



Distribution map of gas fields and Tr1-2 evaporate seal in Sichuan Basin

1.5 Effectiveness of preservation conditions



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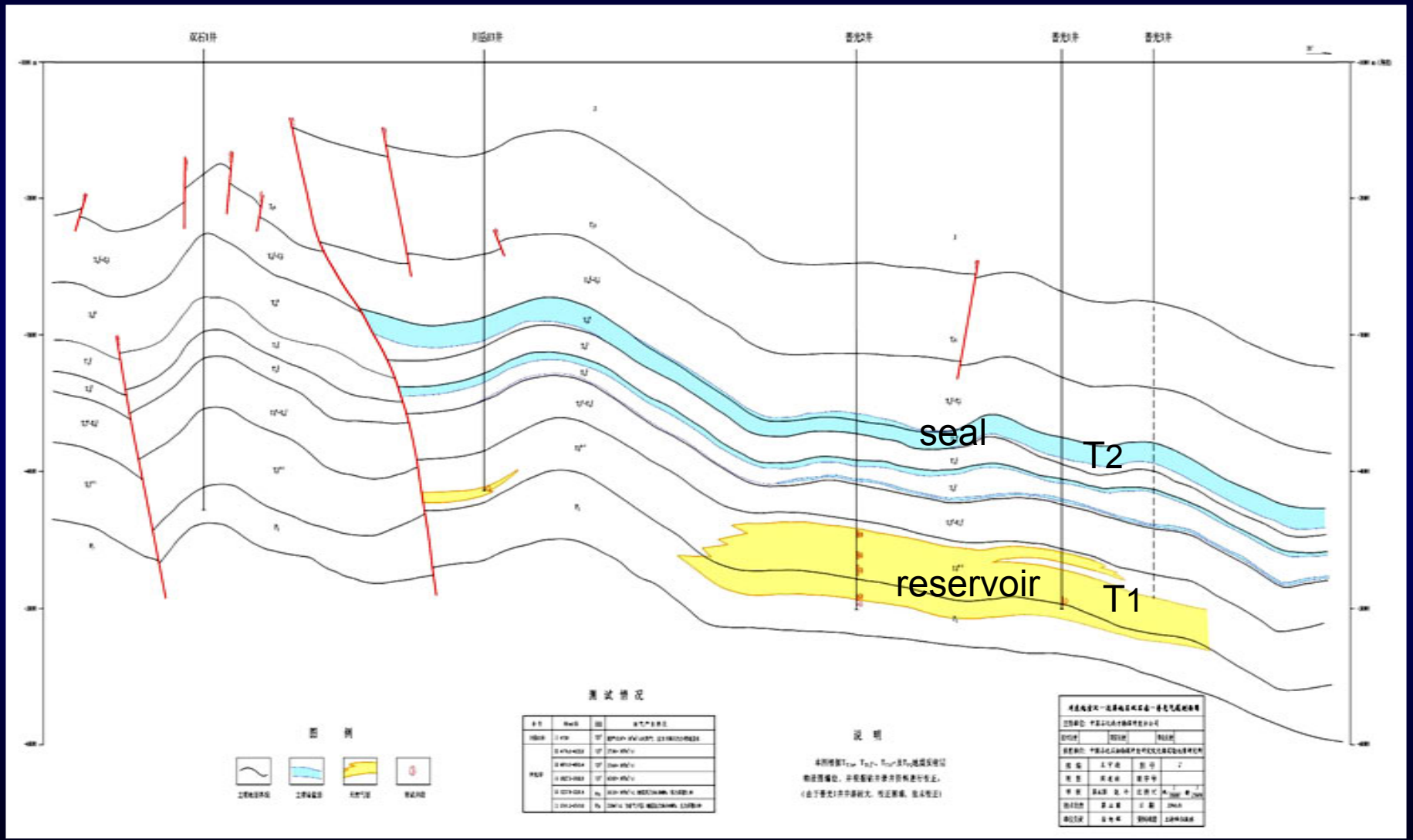

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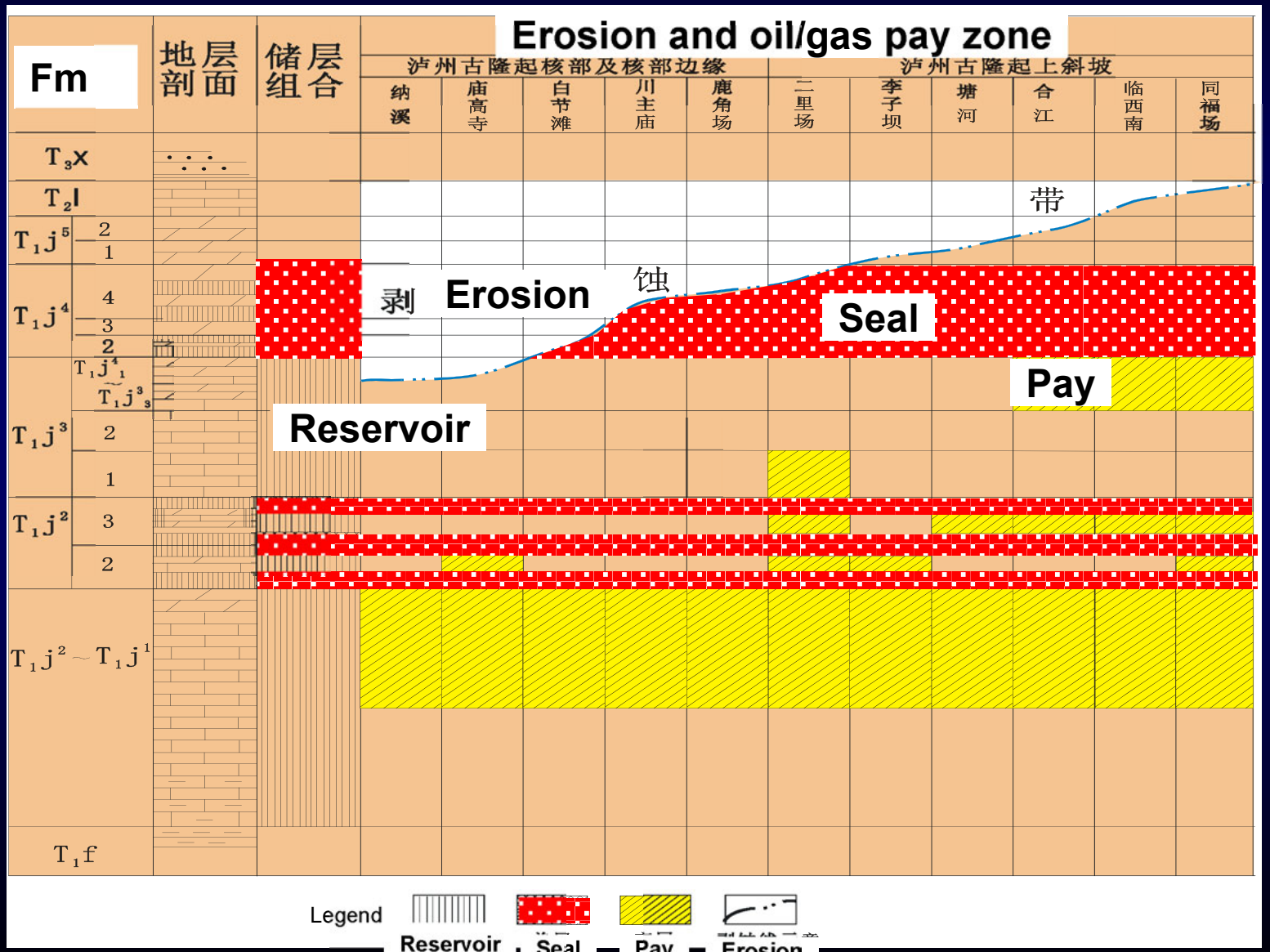

Outline

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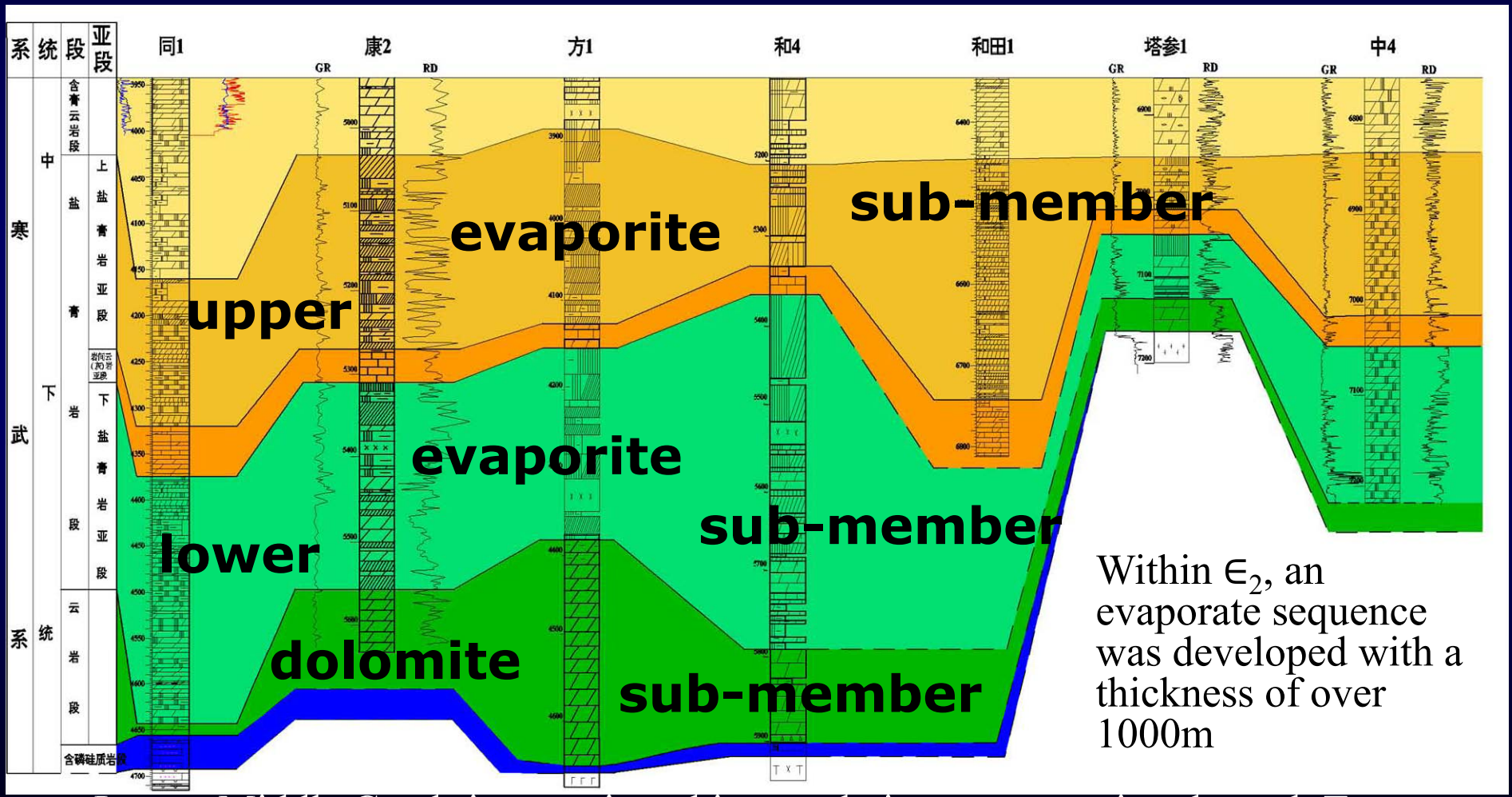
2. Forecast of oil and gas distribution in marine sequences in China

2.1 Exploration plays for the Lower Paleozoic carbonates in Tarim Basin



Lower-Middle Cambrian stratigraphic correlation cross-section through Tong 1-Kong 2-Fang 1-Hetian 1-Tacan 1-Zhong 4 wells.

2. Forecast of oil and gas distribution in marine sequences in China

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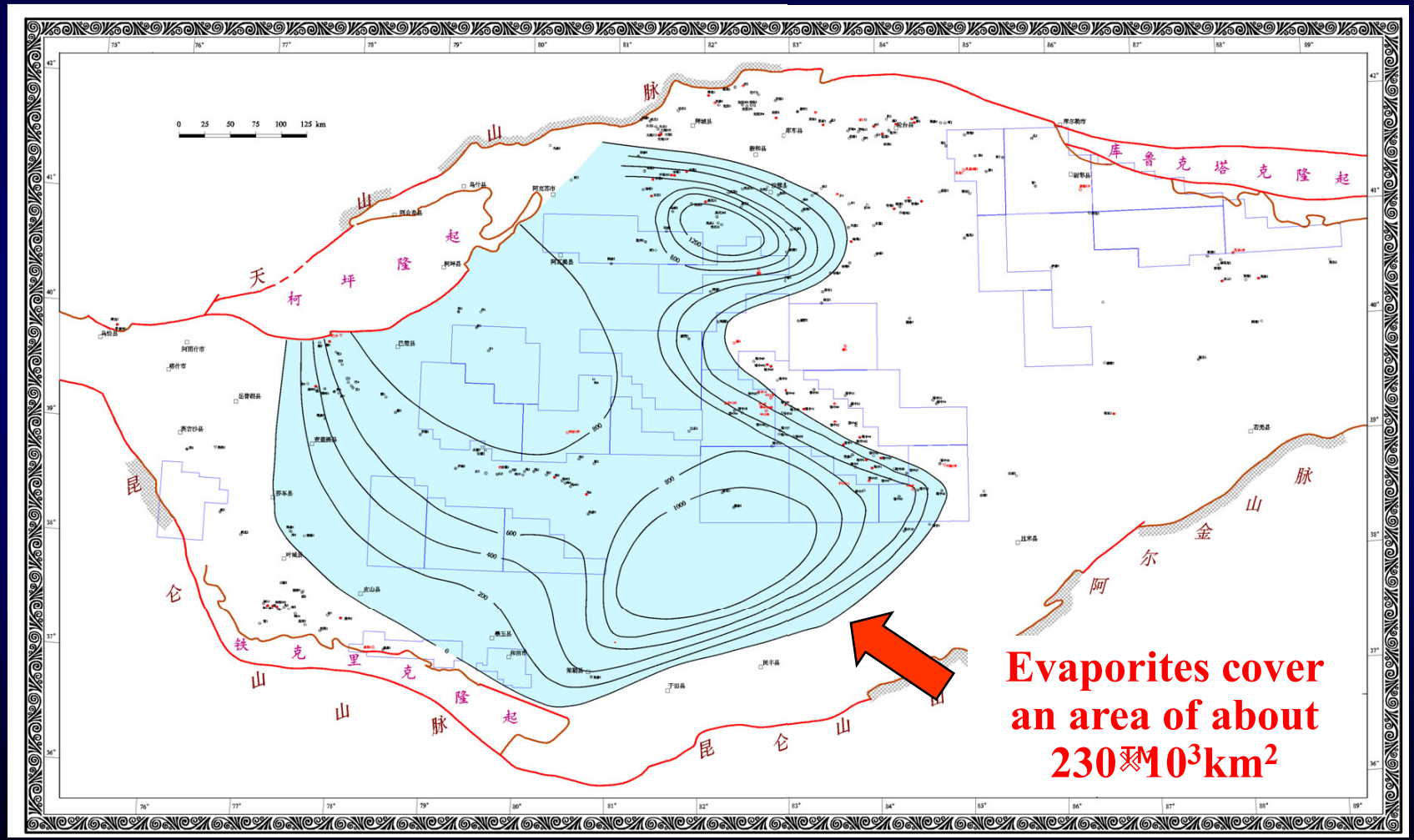
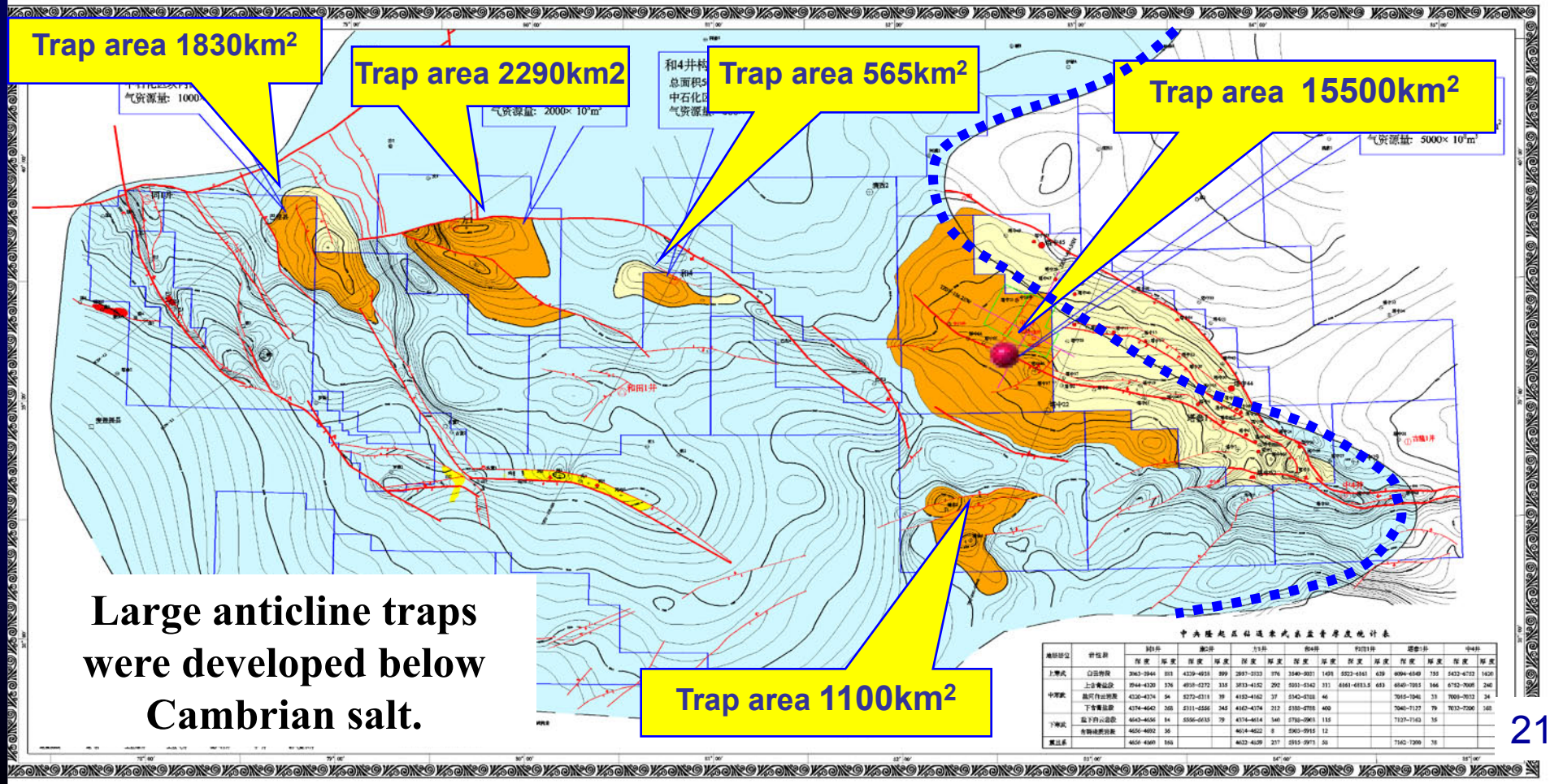


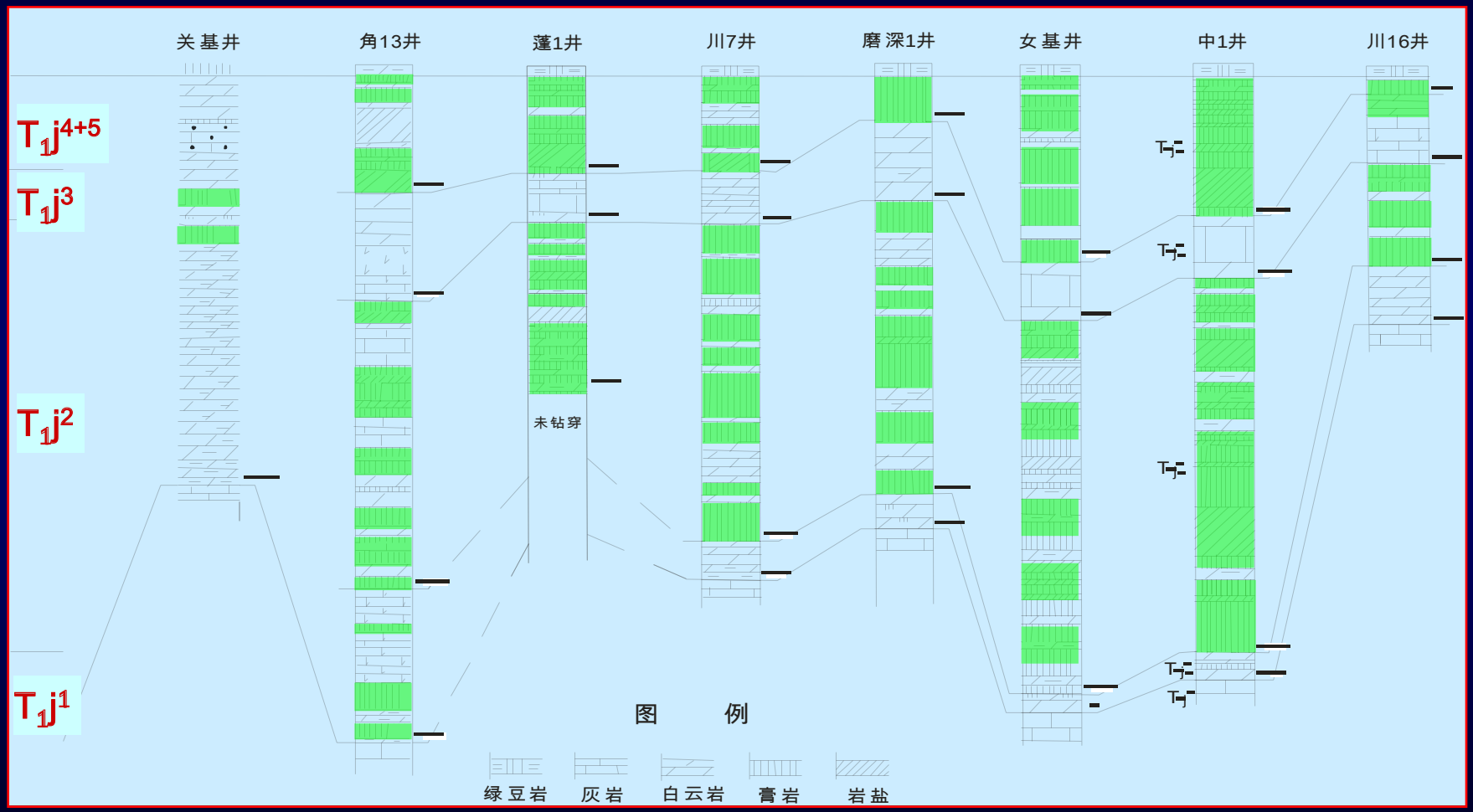
2.1 Exploration plays for the Lower Paleozoic carbonates in Tarim Basin

Integrated evaluation map for Cambrian sub-salt play in Central Uplift of Tarim B



2. Forecast of oil and gas distribution in marine sequences in China

2.2 Exploration plays for the Mesozoic carbonates in Sichuan Basin

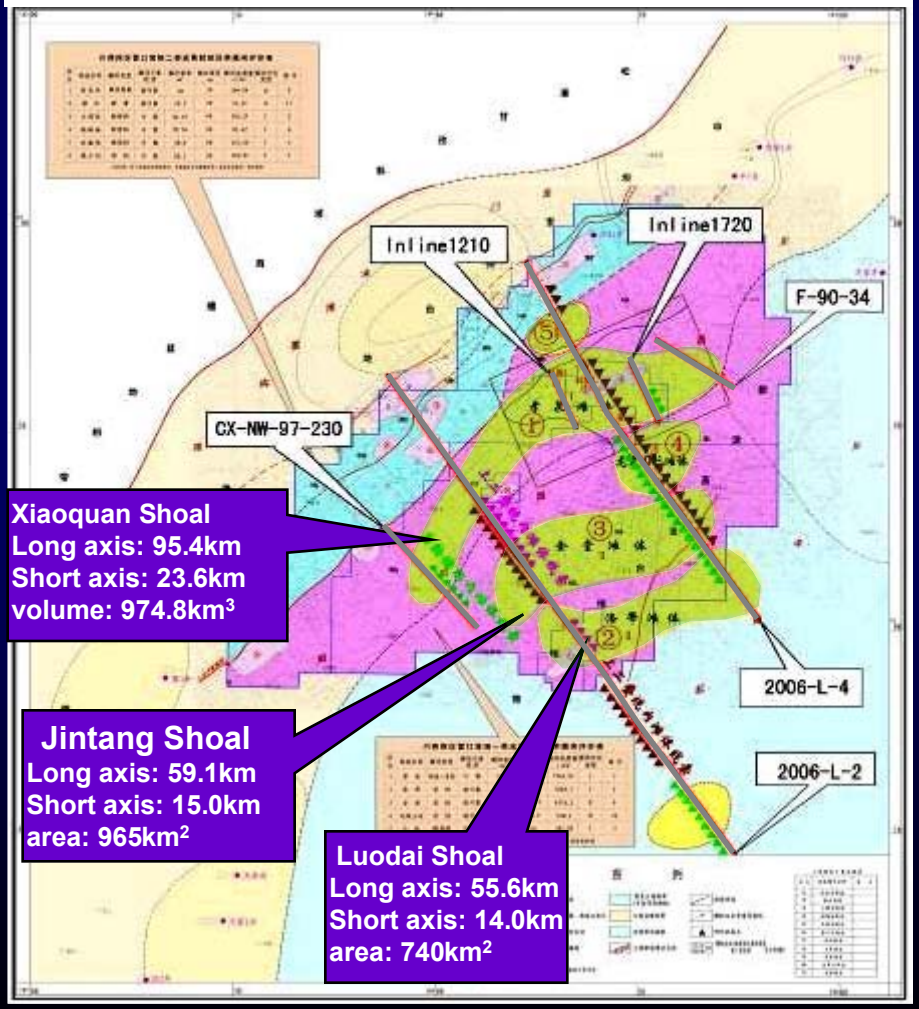


Evaporites in the Lower-Middle Triassic constitute direct seals and Upper Triassic mudrocks make up regional seals.

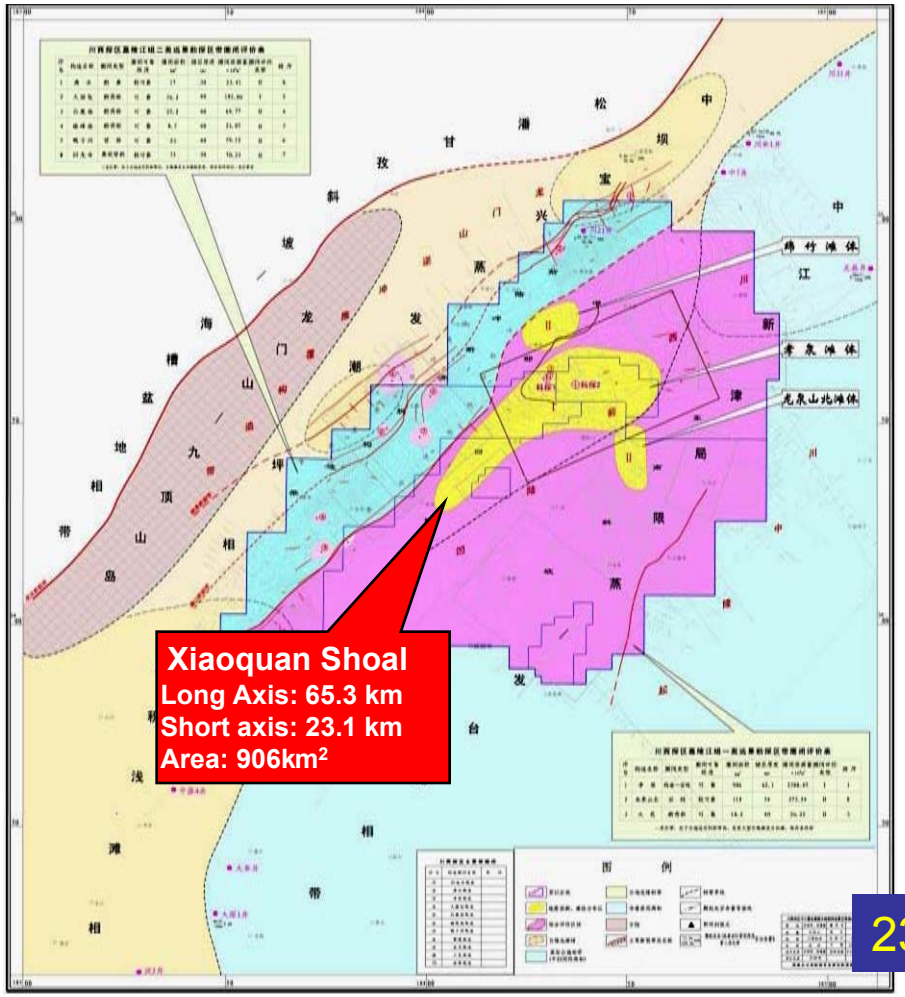
2. Forecast of oil and gas distribution in marine sequences in China

2.2 Exploration plays for the Mesozoic carbonates in Sichuan Basin

Integrated evaluation map for Tr2 Leikoupo Fm in western Sichuan B

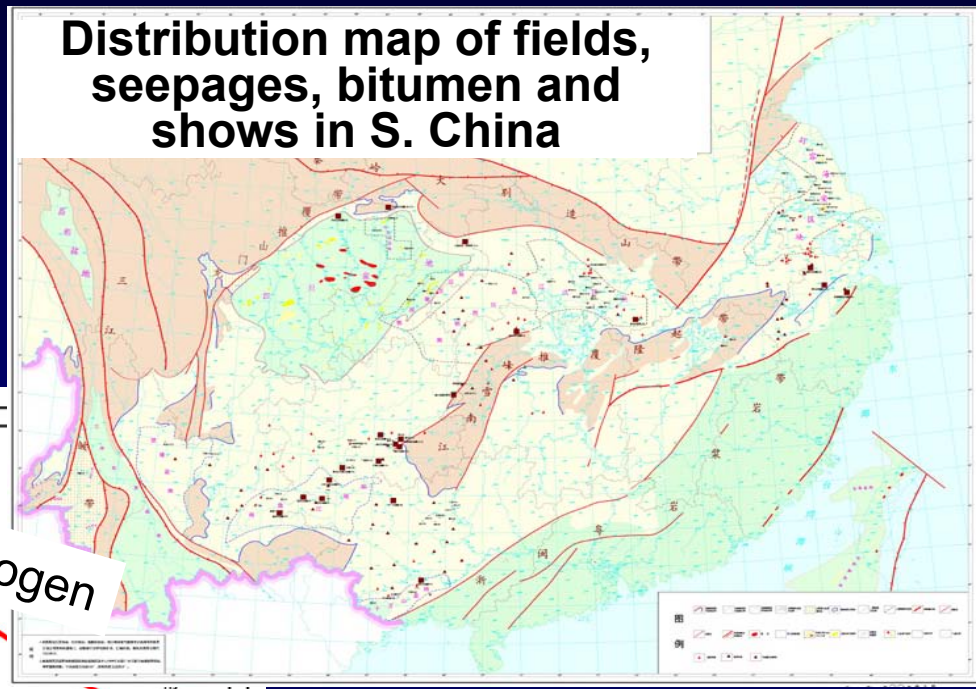


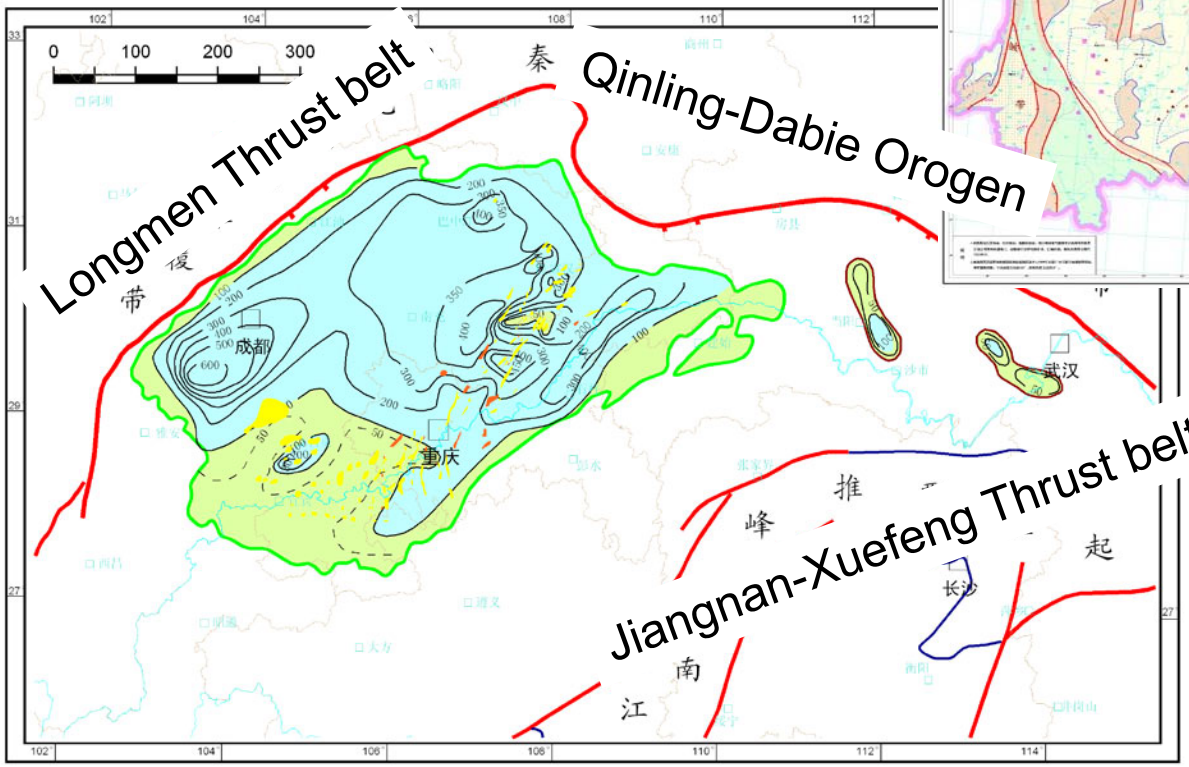
Integrated evaluation map for Tr1 Jialingjiang Fm in western Sichuan B



2. Forecast of oil and gas distribution in marine sequences in China

2.2 Exploration plays for marine carbonates in Sichuan Basin and adjacent areas

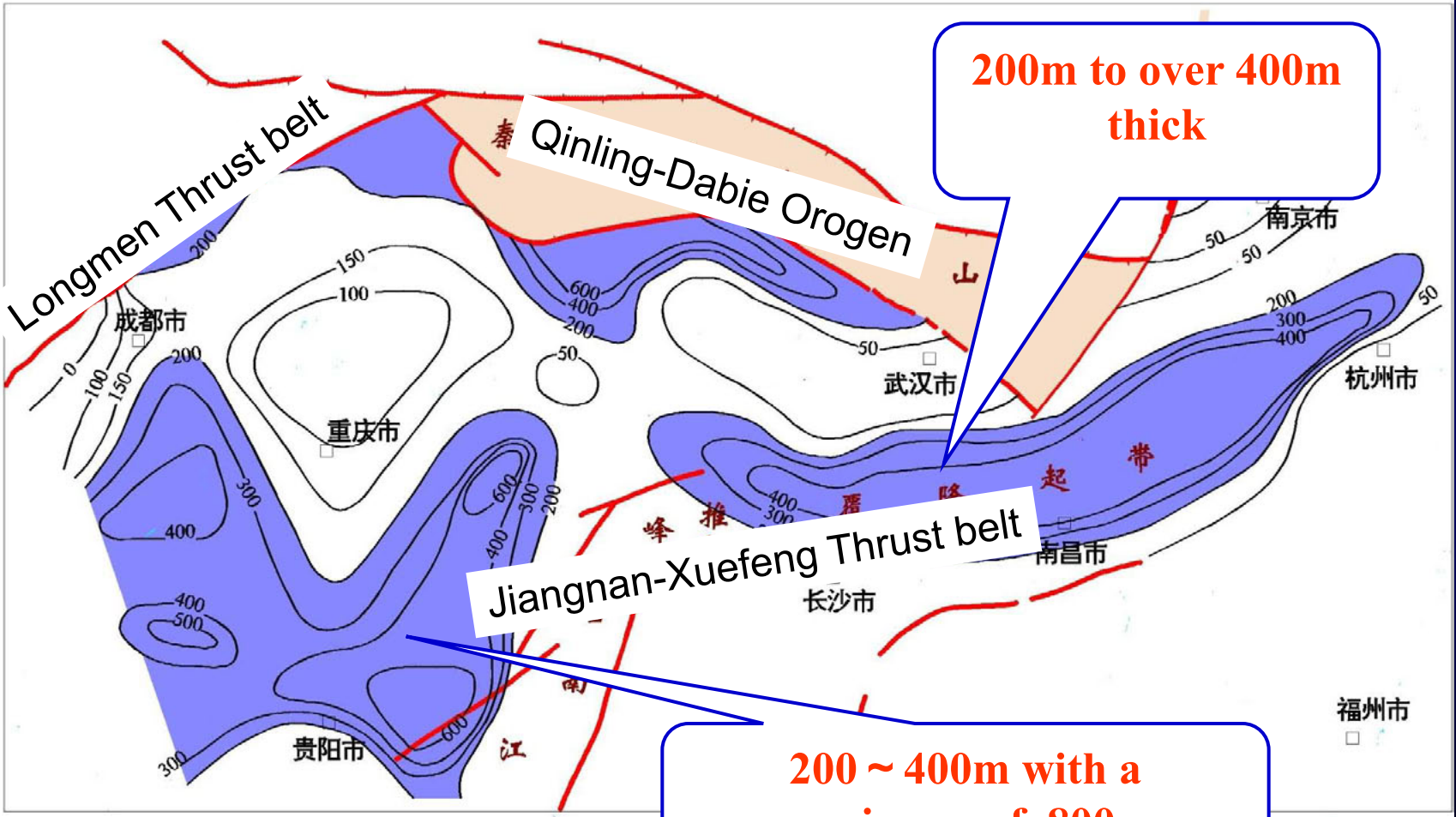




T_{r1-2} evaporate seal is the key for gas enrichment in Sichuan B. Its overlying non-marine overburden (seal) sequences played an essential role in enabling source rocks to enter HC generation window for "2nd time" or in entrapment of late-formed HCs.

2. Forecast of oil and gas distribution in marine sequences in China

Isopach map of Lower Cambrian mudstone seal rocks in South China



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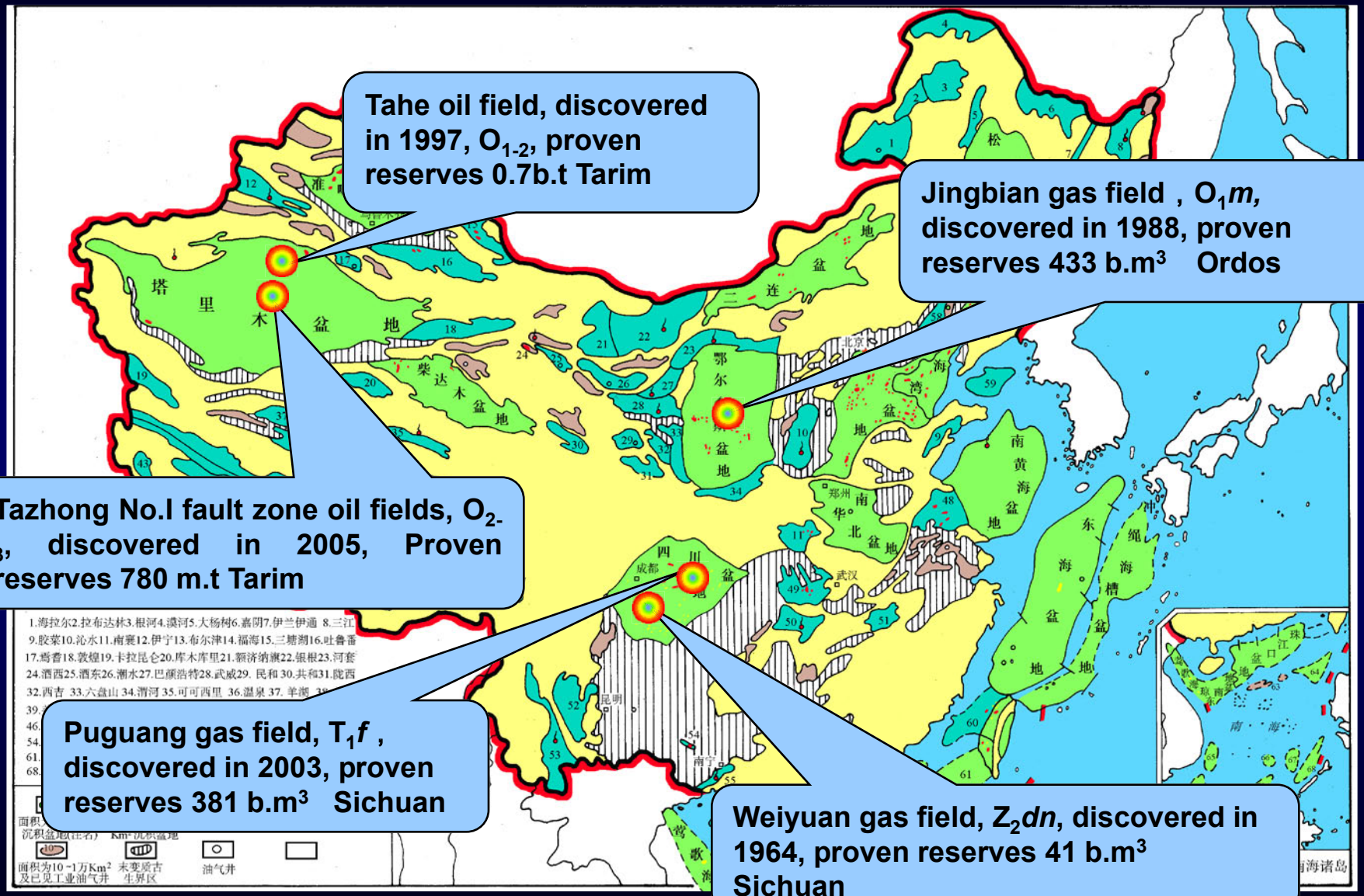


Thanks