

**Combination of basin modeling and pyrrolic nitrogen compounds to
investigate the secondary oil migration pathway in the Dongying
Depression of Bohai Bay Basin, China**

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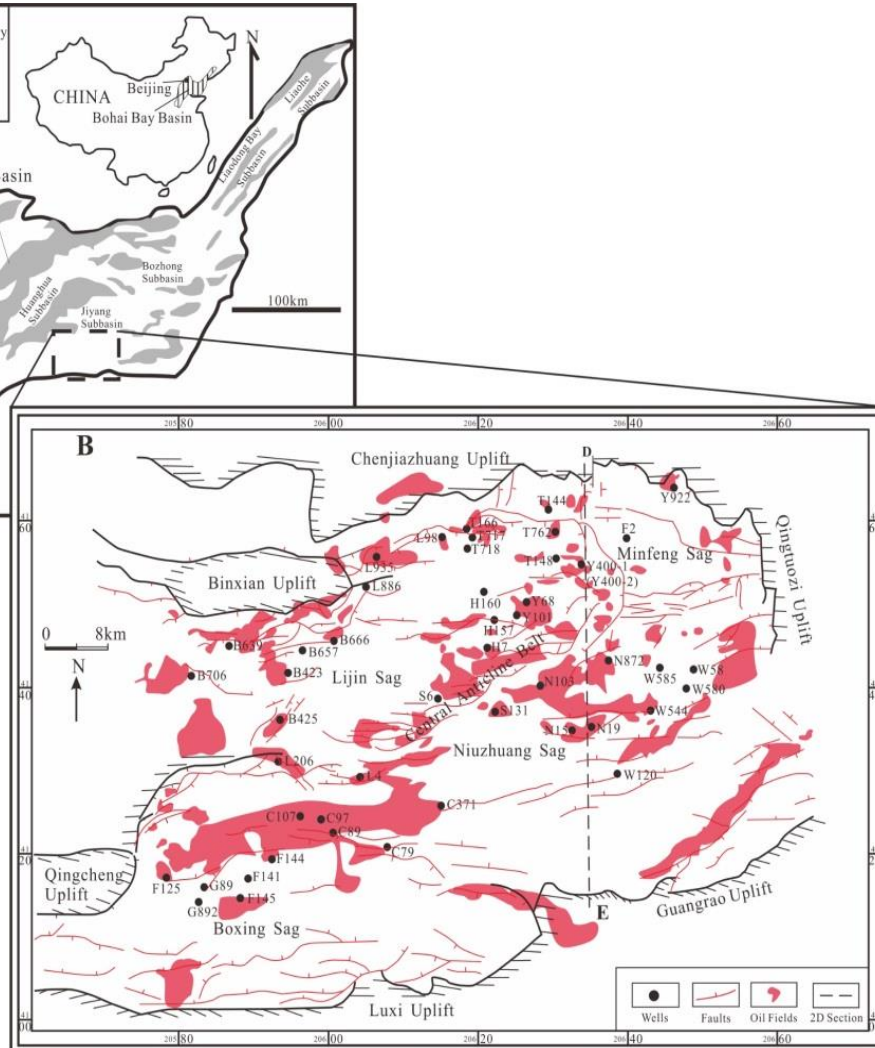
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Content

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The research on **oil migration** is vital for **successful petroleum exploration**. More than 30 oilfields have been discovered in the Dongying Depression. With the **difficulty of exploration** increasing gradually, it is necessary to reconstruct secondary oil migration pathways to **understand oil accumulation**. In this study, an integrated method of **oil migration modeling** and **pyrrolic nitrogen compounds** analyses is applied to trace secondary oil migration pathways in the Dongying Depression.



Location map of Dongying Depression

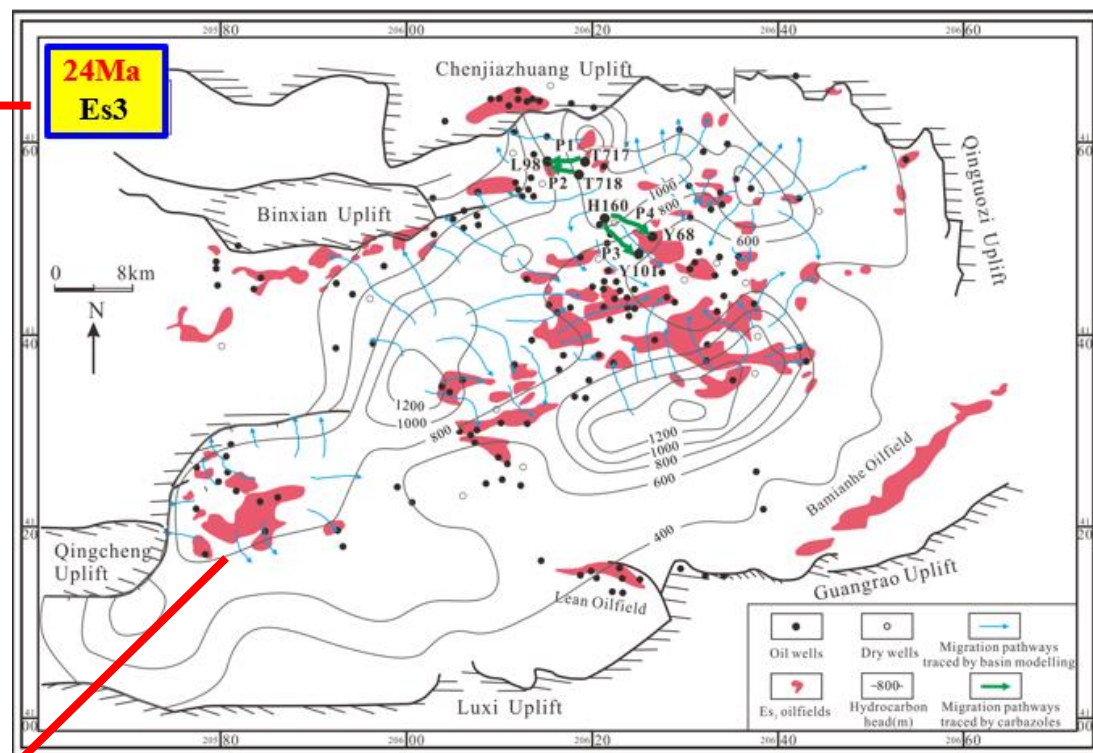
Key issues to be resolved

The timing of oil charge



- Oil generation history modeling
- Fluid inclusion analyses

Secondary oil migration pathways are traced at the time of oil charge

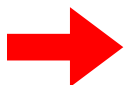


Contour maps of hydrocarbon head in the Es₃ Formation at 24 Ma

Trace secondary oil migration pathway



Basin modeling



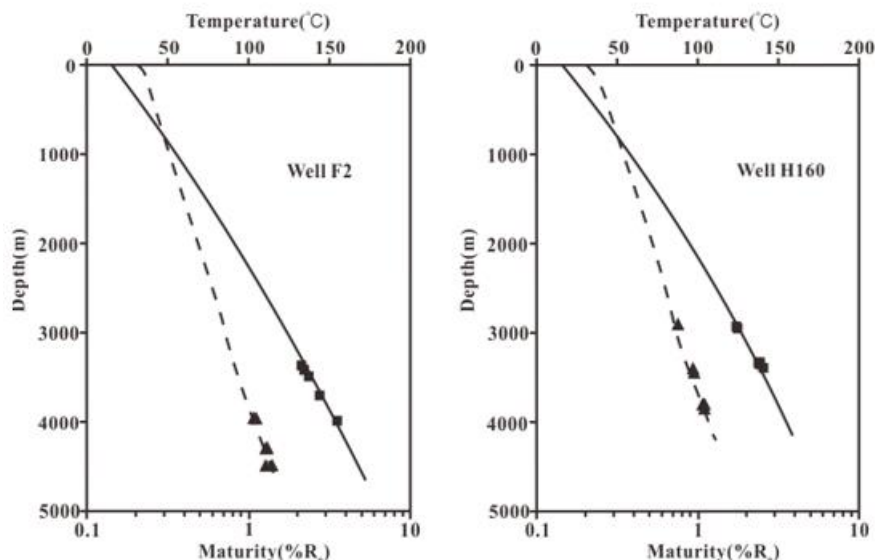
Reliable?



Verification

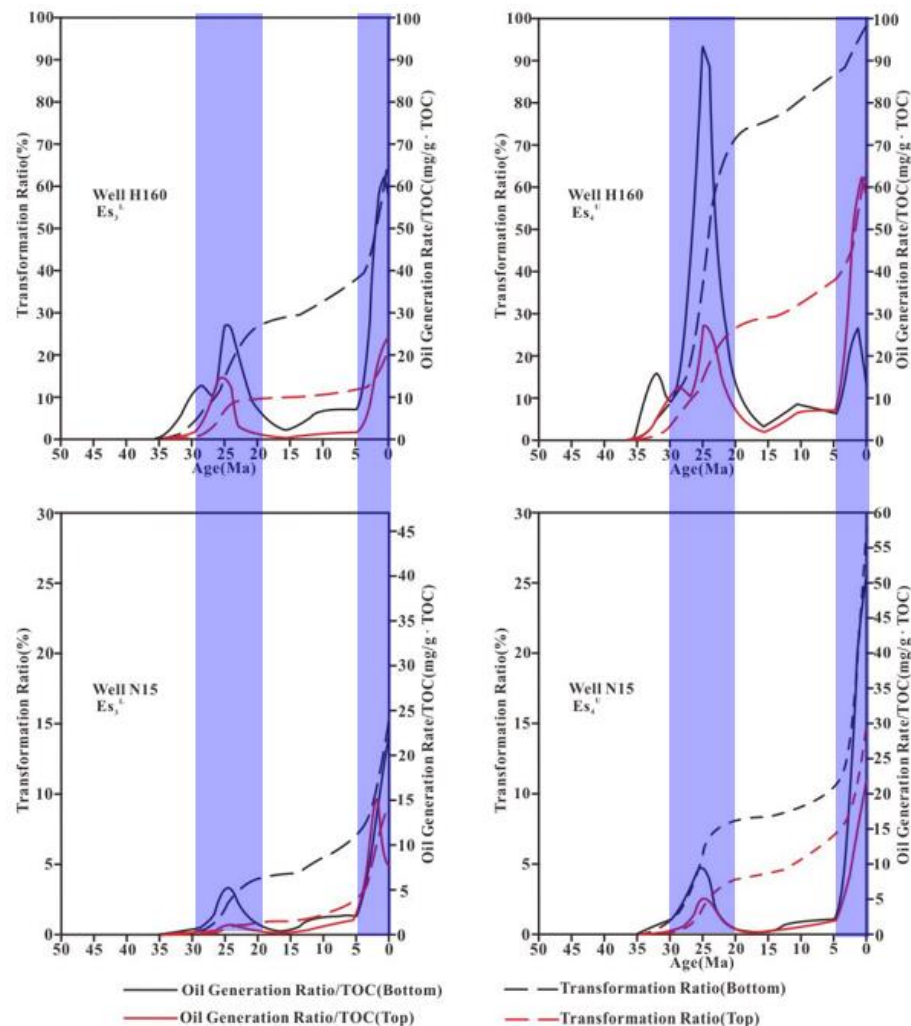
- Pyrrolic nitrogen compounds
- Locations of oil wells and fields

Calibrate the thermal maturation history

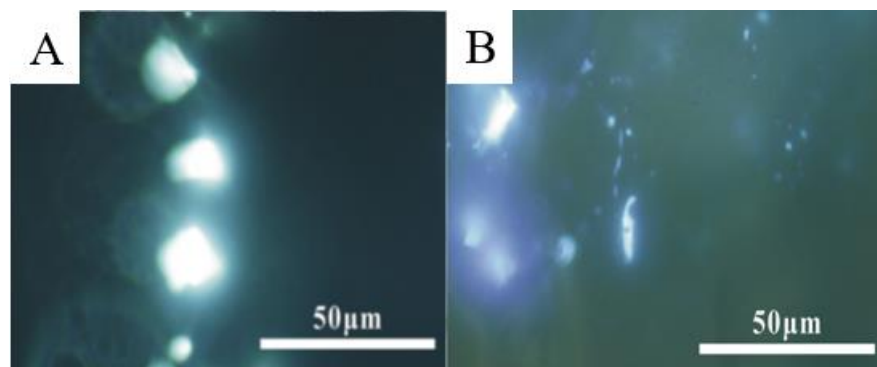


Cross plots of the modeled and measured R₀ and temperature versus depth

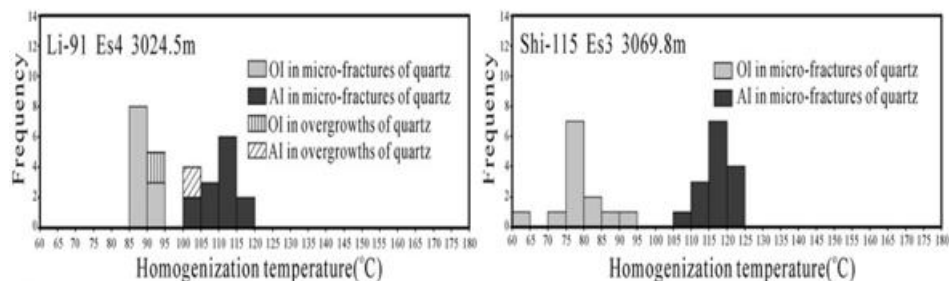
Oil generation history modeling is conducted to obtain the main period of oil generation. The timing of oil generation is from **30 to 20 Ma** and from **5 to 0 Ma**.



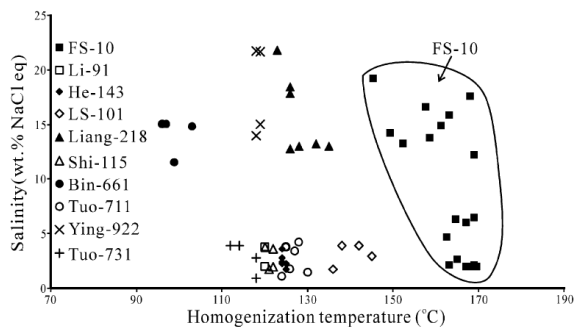
Oil generation history of Es₃ and Es₄ source rocks



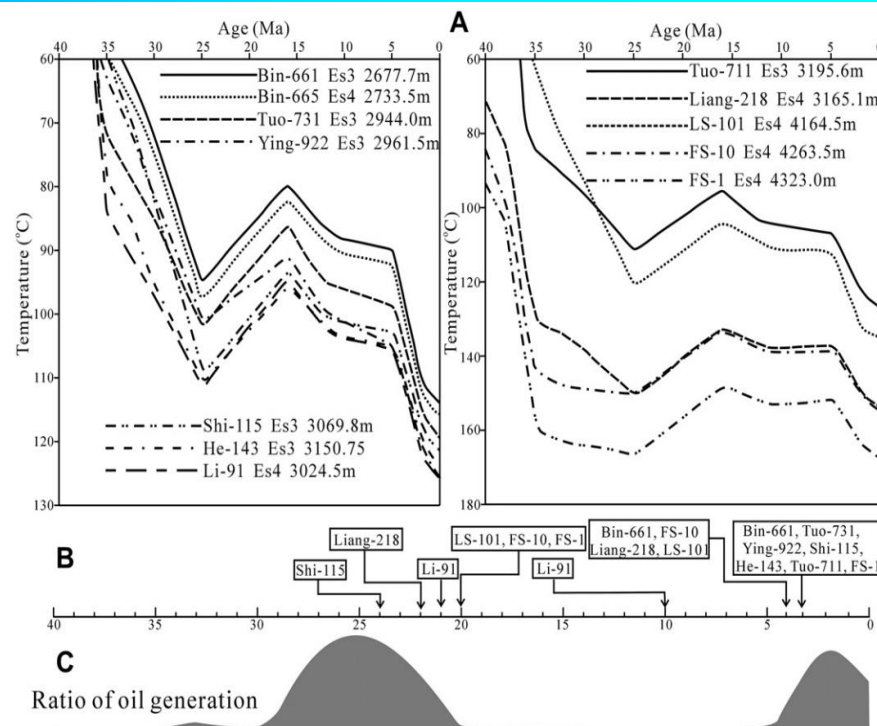
Photos of oil inclusions under transmitted light and UV light



Histograms of homogenization temperature for oil inclusions and associated aqueous inclusions in quartz and calcite in carrier rocks

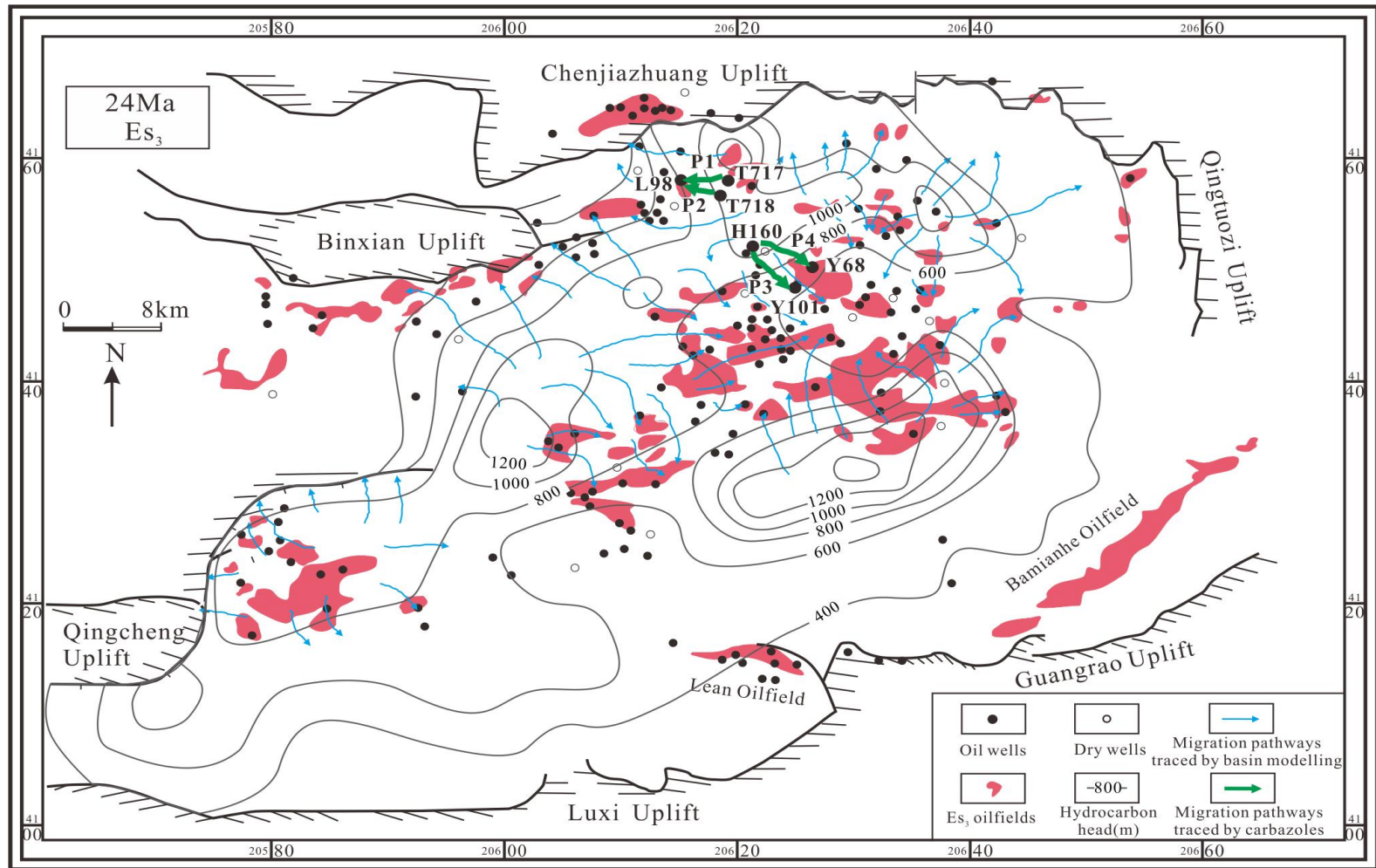


Cross plot of homogenization temperature and salinity of aqueous inclusions coeval with oil inclusions



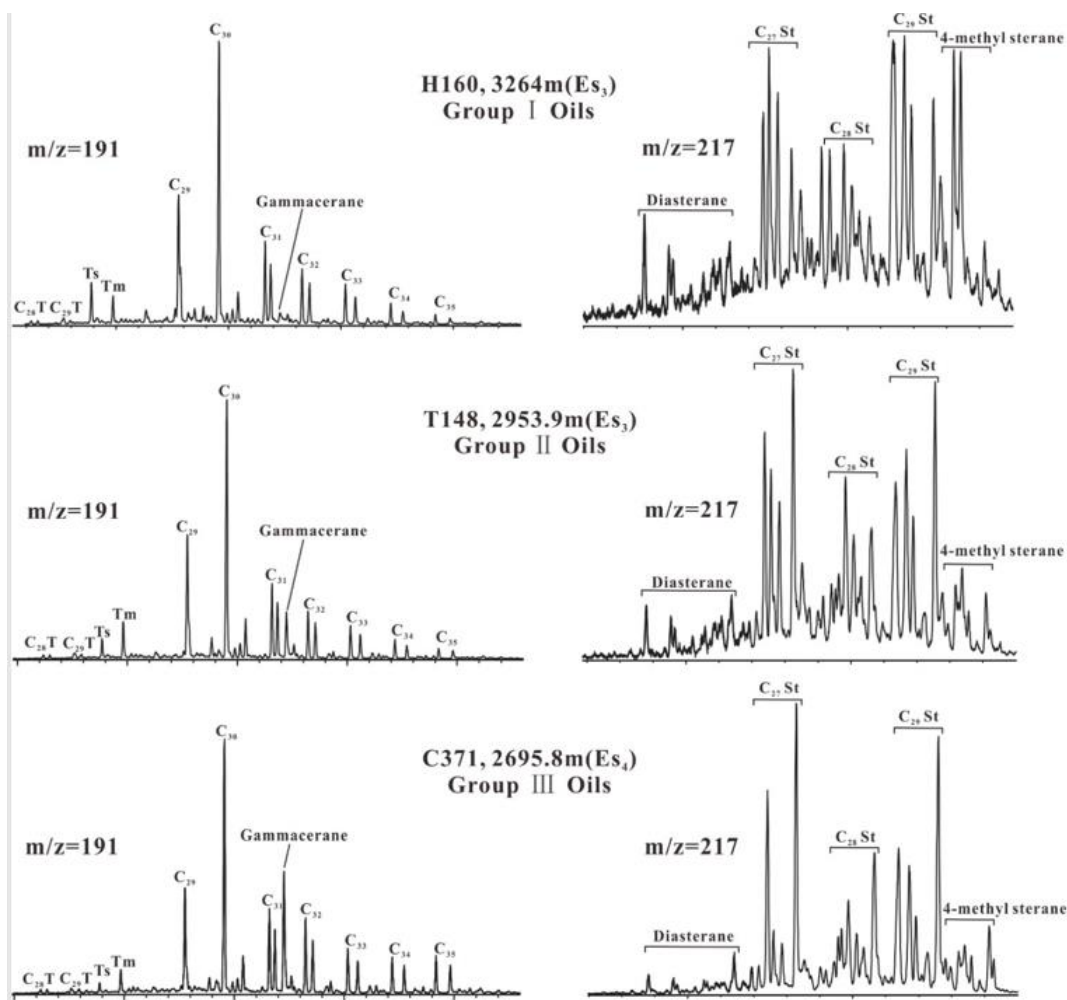
A: Thermal history plots; B: The timing of oil charge inferred by homogenization temperature of aqueous inclusions coeval with oil inclusions; C: Oil generation history

Fluid inclusions analyses and thermal history modeling are conducted to obtain the main period of oil charge. The timing of oil charge is from 24 to 20 Ma and from 4 to 3 Ma and correspond with the timing of oil generation.



Contour maps of hydrocarbon head in the Es₃ Formation at 3 Ma

The oil migration pathways in the Dongying Depression are traced by basin modeling at the time of oil charge.



Representative mass chromatograms of m/z 191 and 217 of three groups oils.

The parameters of pyrrolic nitrogen compounds, which are related with the length of oil migration distance, can be influenced by biodegradation, source facies and maturity. Therefore, the oil samples should be classified first.

Similar abundance of C₂₇ and C₂₉ steranes



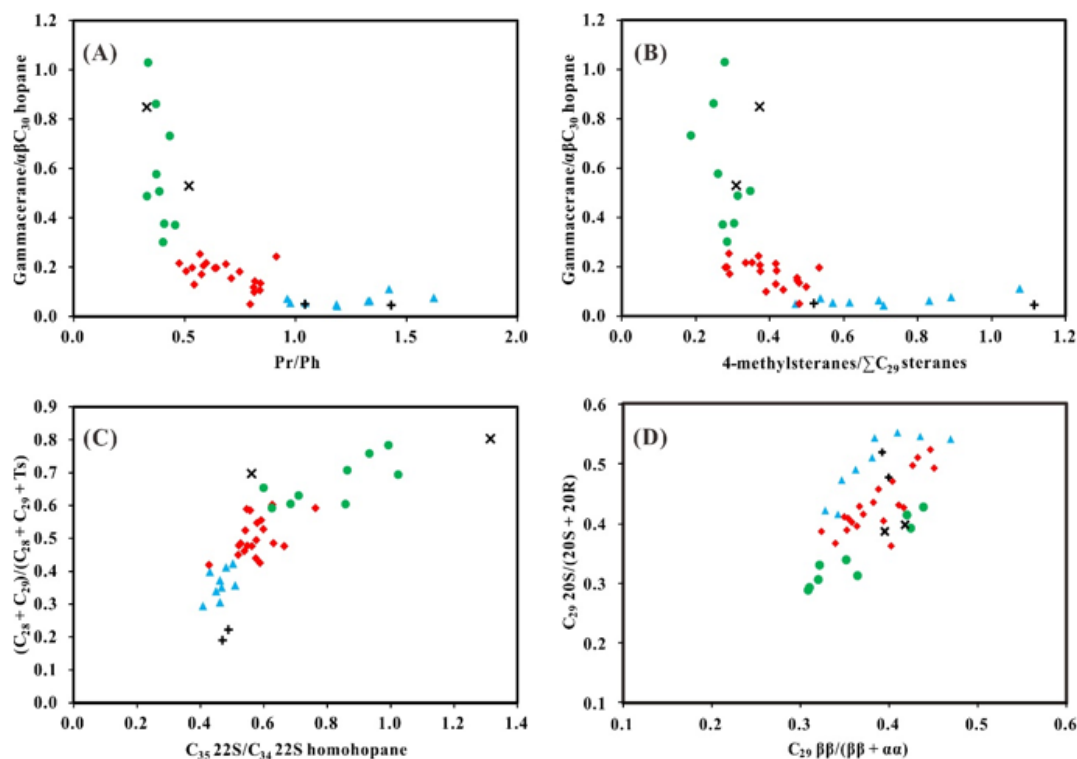
Similar origin of organic matter

No UCM hump



Non-biodegraded

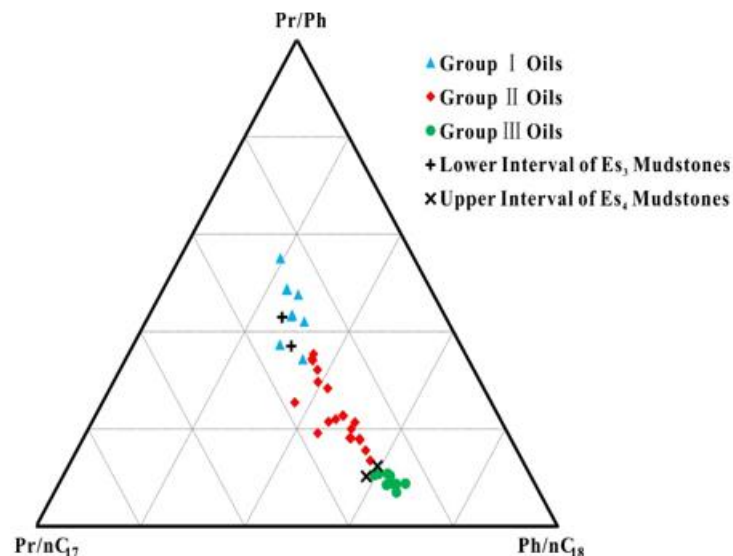
1-/4-MC, 1,8-/2,7-DMC and [a]/[a]+[c] parameters can be influenced by **source facies**, **maturity** and **biodegradation**.



Cross plots of biomarker parameters for the oil and mudstone samples.

By comparing the depositional environment parameters, three groups oils are classified.

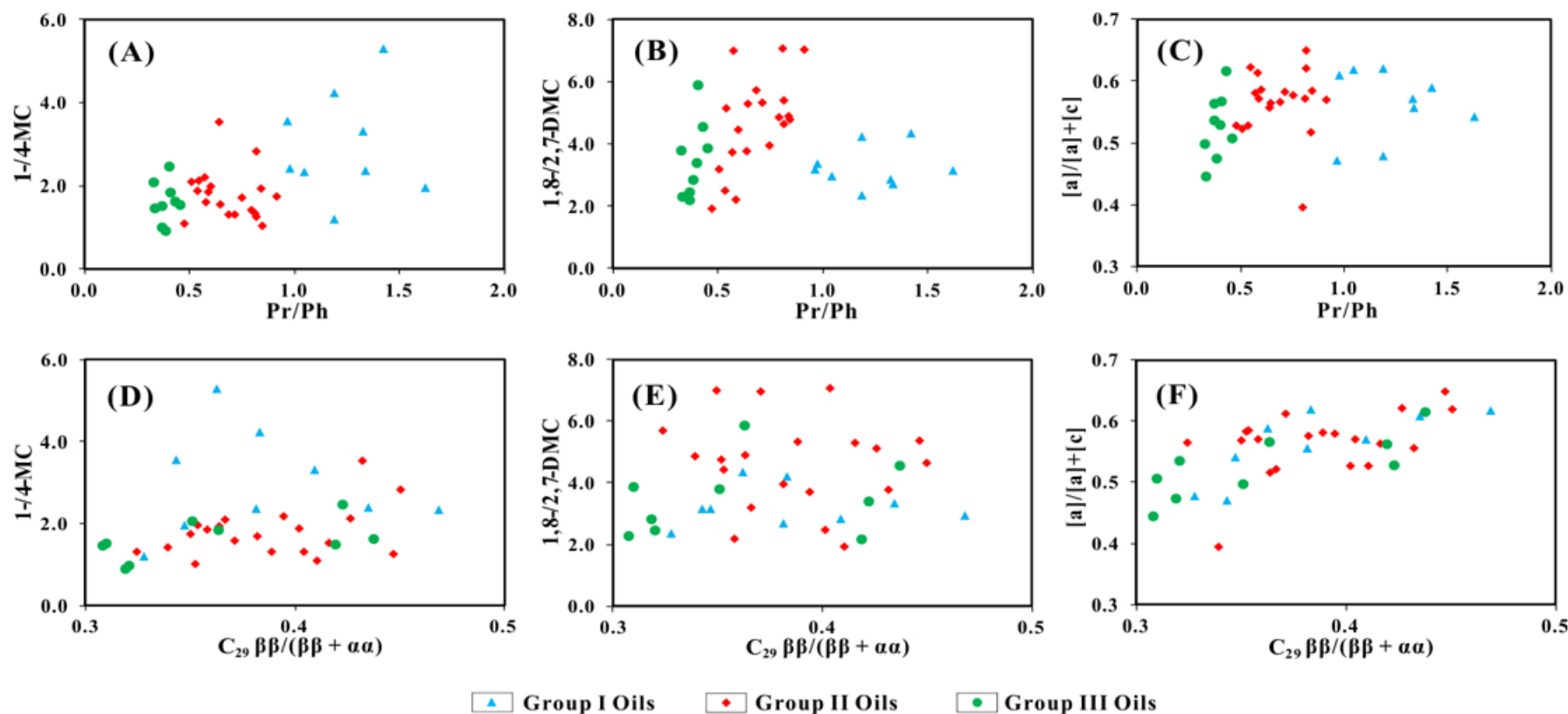
- ①. **Group I oils** are generated from Es₃ source rocks;
- ②. **Group III oils** originate from Es₄ source rocks;
- ③. **Group II oils** are mixing of Es₃ and Es₄.



Similar C₂₉ 20S/(20S+20R), MPI-1, Ts/Ts+Tm, and C₂₉ ββ/(ββ+αα) values



Similar maturity

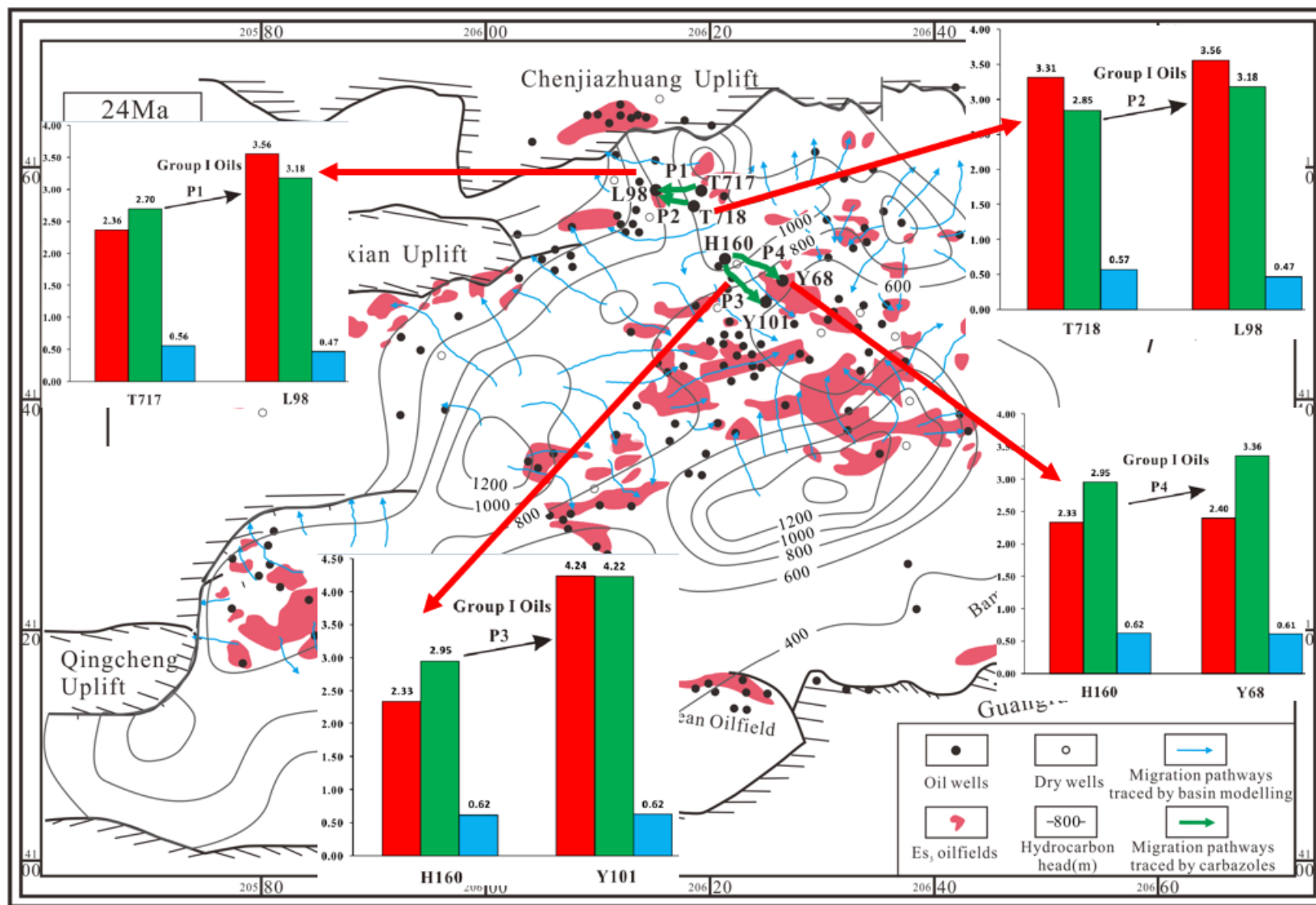


Cross plots of 1-/4-MC, 1,8-/2,7-DMC, $[a]/[a]+[c]$ versus Pr/Ph and $C_{29} \beta\beta/(\beta\beta + \alpha\alpha)$

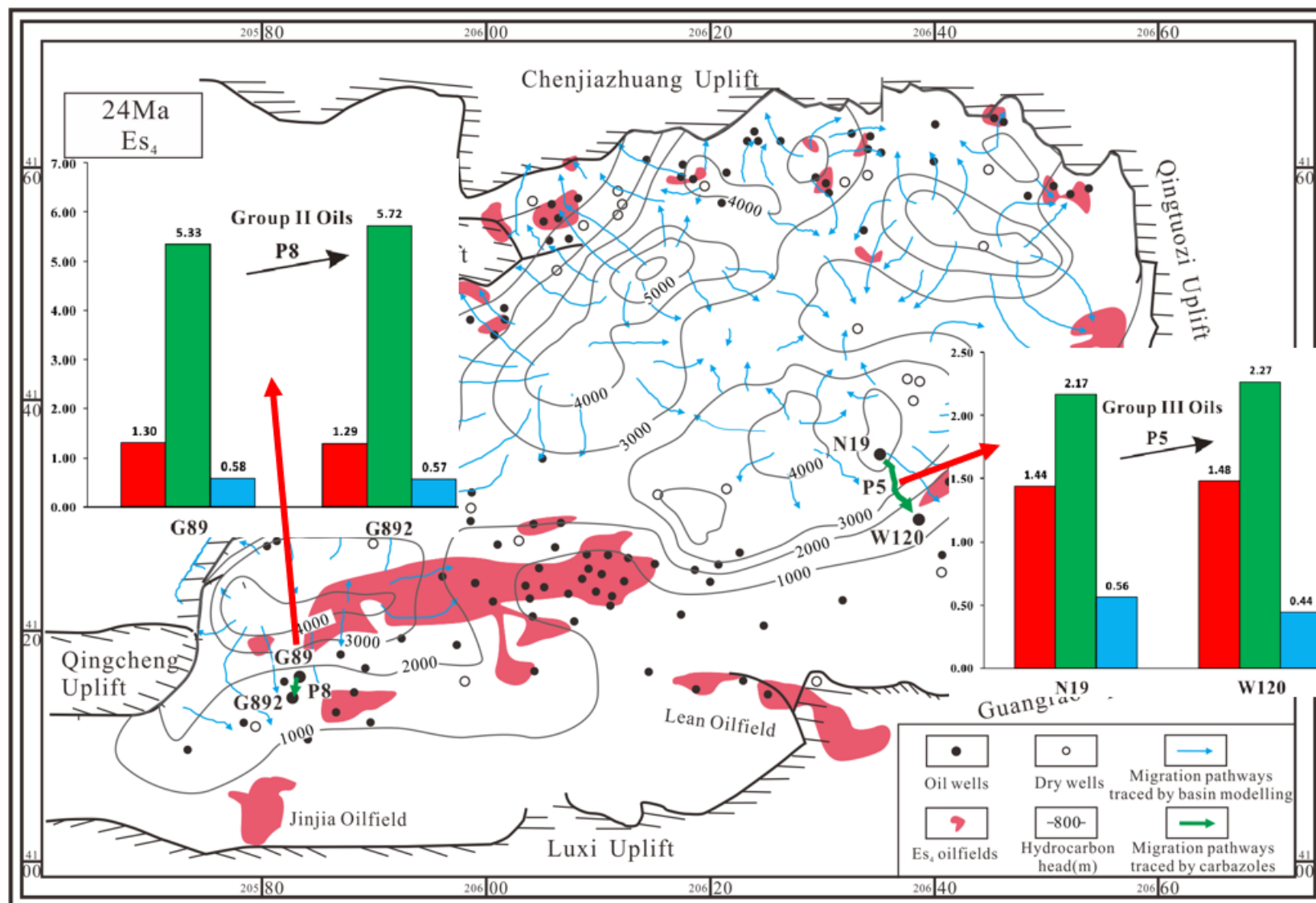
Thermal maturity **don't affect** parameters of pyrrolic nitrogen compounds.

In each group oils, the influence of source facies on these parameters is **little**.

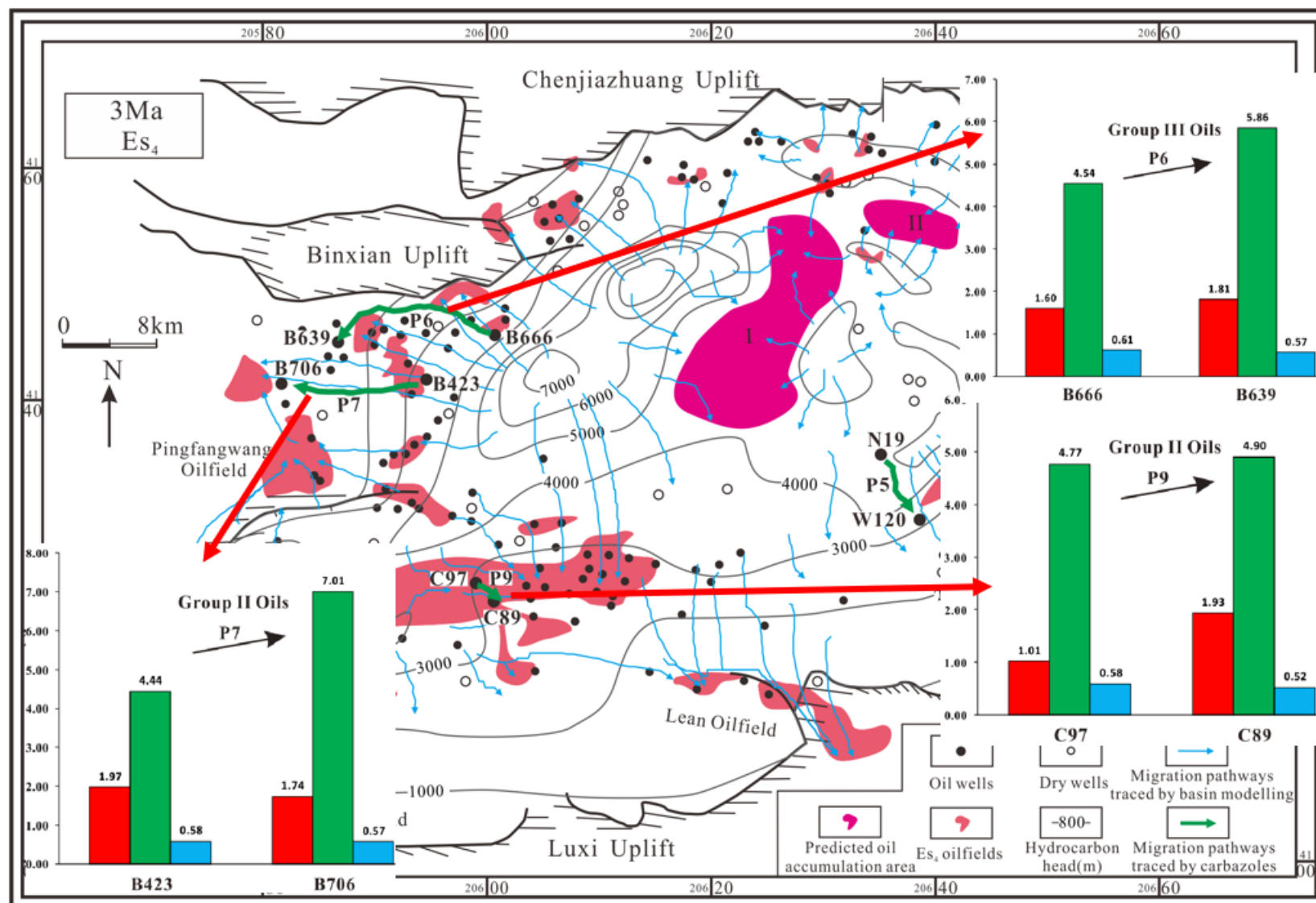
Migration distance is the main factor influencing these parameters in **each group oils**.



Contour maps of hydrocarbon head in the Es₃ Formation at 24 Ma



Contour maps of hydrocarbon head in the Es₄ Formation at 24 Ma



Contour maps of hydrocarbon head in the Es₄ Formation at 3 Ma

- There are two main periods of oil charge, i.e. 24-20 Ma and 4-3 Ma, respectively.
- The crude oils in the Dongying Depression display similar maturity and origin of organic matter; they can be separated into three groups based on the depositional environment parameters
- Most of the oil wells and fields are on the modeled migration pathways, the pathways determined by basin modeling are in good agreement with those traced by pyrrolic nitrogen compounds.
- Oil accumulation may be mainly controlled by oil migration pathways and two favourable oil accumulation areas are predicted in the Es₄ Formation.

Thanks for watching!

Welcome to ask questions!

