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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Key issues to be resolved

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.
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 Es$_3$ Formation at 24 Ma

Trace secondary oil migration pathway

Verification

➢ Pyrrolic nitrogen compounds
➢ Locations of oil wells and fields
Calibrate the thermal maturation history

Cross plots of the modeled and measured $R_o$ 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 $E_{3}$ and $E_{4}$ source rocks
The timing of oil charge

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.

Cross plot of homogenization temperature and salinity of aqueous inclusions coeval with oil inclusions
The oil migration pathways in the Dongying Depression are traced by basin modeling at the time of oil charge.
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.

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

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

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 Es$_3$ source rocks;
2. **Group III oils** originate from Es$_4$ source rocks;
3. **Group II oils** are mixing of Es$_3$ and Es$_4$.

**Similar C$_{29}$ 20S/(20S+20R), MPI-1, Ts/Ts+Tm, and C$_{29}$ ββ/(ββ+αα) values**

**Similar maturity**
Migration pathways tracing

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.
Migration pathways tracing

Contour maps of hydrocarbon head in the Es$_3$ Formation at 24 Ma
Migration pathways tracing

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

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

- 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!