GEOCHEMICAL CHARACTERISTICS OF TYPICAL FRESHWATER AND SALTLAKE LACUTRINE SOURCE ROCKS IN CHINA

Zhang Bin¹, Zhang Shuichang¹, Chen Yan²

1 Research Institute of Petroleum Exploration & Development, PetroChina
2 Research Institute of Petroleum Exploration & Development, PetroChina Qinghai Oilfield Company
(*correspondence: zhangbin01@petrochina.com.cn)

Introduction

Over 90% of the crude oil produced in China comes from terrestrial source rocks. Studies show that there are two main types of lacustrine source rocks: freshwater lacustrine and saltwater lacustrine source rocks (Zhai et al, 1996). The former is mainly distributed in the Triassic of Ordos Basin and Jurassic of Sichuan Basin, while the latter is mainly distributed in the Permian of Junggar Basin and Paleogene of Qaidam Basin. In this paper, the geochemical characteristics of the two types of source rocks are compared, and the difference of hydrocarbon generation potential between the two types of source rocks is carefully evaluated.

Results

The total organic carbon (TOC) content of source rocks of Paleogene in Qaidam Basin (saltwater) and Jurassic (freshwater) in Sichuan Basin is generally 1%~3%, while that of Permian in Junggar Basin (saltwater) and Triassic (freshwater) in Ordos Basin is 10%~30%. It can be seen that there is no significant difference in organic matter abundance between freshwater and saline lacustrine source rocks.

The type of the organic matters is different. Freshwater lacustrine source rocks are dominated by type II organic matters, with hydrogen index (HI) generally not more than 600 mg/g TOC, while saline lacustrine source rocks are dominated by type-I and type-II organic matters, with HI generally ranging from 400 to 900 mg/g TOC. It shows that the organic carbon of saline lacustrine source rocks has higher hydrocarbon potential.

Freshwater lacustrine source rocks are rich in rearranged steranes, rearranged hopanes, 18α(H)-22,29,30-C27-trinorhopane (Ts) and early-eluting rearranged hopanes, with little gammacerane or phytane, indicating that organic matter has undergone strong bacterial transformation (Peters, et al, 2005). The source rocks of saline lacustrine are rich in gammacerane, phytane, 17α(H)-22,29,30-C27-trinorhopane (Tm), carotenoids and alkyl isoprene alkylbenzene (Zhang et al, 2011; Zhang et al, 2018; figure 1). There are almost no rearranged steroids or rearranged hopane. This indicates that the organic matter mainly comes from aquatic organisms in quiet and anoxic water with little bacterial transformation, resulting in well-preserved oil-generating components.

The kinetics of hydrocarbon generation shows that both source rocks have similar activation energy, indicating that freshwater and saline lacustrine kerogen generate hydrocarbon in same thermal evolution extent. However, the saline lacustrine source rocks are abundant of ‘soluble
organic matters’, which can generate some liquid hydrocarbons in a relatively low maturity. The molecular weight of hydrocarbon produced by freshwater lacustrine source rocks is less than that of saline lacustrine source rocks, which contains more alkanes and is conducive to flow.

Conclusions

The organic matter in saline lake source rocks has good preservation conditions, more hydrogen-rich components, high oil-generating potential per unit organic matters, and can generate some low mature oil; while the hydrocarbons generated from freshwater lake source rocks have low molecular weight and low density.

References