Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.33202

Carbon Isotopes, Hydrocarbons, and NSO Compounds in Diverse Lithofacies Shales: Insights Into Shale Oil Mobility

JIANGUO YANG[1,2], FEI XIAO[1,2], SHICHAO LI[1,2], YULAI YAO[1,2] AND YIMING HUANG[1,2]

[1]Shenyang Center of China Geological Survey/Northeast Geological S&T Innovation Center of China Geological Survey
[2]Shale Oil Technology Innovation Center of China Geological Survey

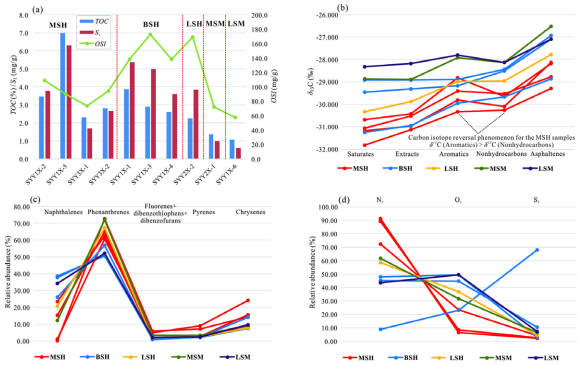

Fig.1 Geochemical distribution diagrams of different lithofacies in the Qing1 shales of the Songliao Basin: (a) Basic geochemical parameters, (b) Carbon isotopes, (c) Aromatics, and (d) NSO compounds in the negative ion mode.

Shale oil is an important unconventional resource. China has accelerated its exploration, notably in the Songliao Basin, where the matrix-type oil (predominant in China) is stored within shale pores and micro-fractures. The mobility of this oil, critical for development, depends on its molecular composition. This study focused on the first member of the Upper Cretaceous Qingshankou Formation (Qing1) shale layer in the Songliao Basin. Based on the classification by Yao et al. (2024), the studied lithofacies include: massive siliceous mudstone with high TOC (TOC >2.0%) (MSH), bedded siliceous mudstone with high TOC (BSH), laminated siliceous mudstone with high TOC (LSH), massive siliceous mudstone with moderate TOC (1.0%< TOC <2.0%) (MSM), and laminated siliceous mudstone with moderate TOC (LSM). We investigated the composition of carbon isotopes, hydrocarbons, and NSO compounds across these lithofacies to assess their effects on oil mobility.

The S_1 and OSI values are higher in high-TOC shales (MSH, BSH, LSH vs. MSM, LSM; Figure 1a), indicating greater free and movable oil contents. Carbon isotope sequencing shows a typical positive trend in BSH but local reversals (e.g., aromatics > nonhydrocarbons) in MSH (Figure 1b), likely due to enhanced oil mobility from dense lamellar fractures in BSH facilitating component fractionation (Yao et al., 2024). Hydrocarbon analysis reveals BSH is enriched in diaromatic naphthalenes and depleted in tri-/tetra-aromatics relative to MSH and MSM (Figure 1c), while also being depleted in high-polarity N_1 compounds that are enriched in MSH and MSM (Figure 1d). These findings suggest movable oil is enriched in low-ring-number aromatics and low-polarity NSO compounds. Consequently, within the Qing1 shales, movable oil content strongly correlates with lithofacies. BSH, with the highest movable oil content, exhibits the described regular carbon isotope sequence, diaromatic enrichment, and depletion in higher aromatics and N_1 compounds. Integrating these geochemical signatures with lithofacies analysis provides a robust framework for assessing shale oil mobility.

References

Yao, Y., Xiao, F., Li, S., Yang, J., Huang, Y., & Ye, C. (2024), Acta Geologica Sinica 98(11), 3393-3407.

Acknowledgements

This work was jointly funded by National Natural Science Foundation of China (Grant Nos. U2244207 and 42072178).