Hydrocarbon Generation and Expulsion Model for Upper Paleozoic Source Rocks in the Hangjinqi Area, Northern Ordos Basin, China

Huijun Wang[1], Shuangfang Lu[2], Guiping Zhao[3]
[1]China University of Petroleum (East China); [2]China University of Petroleum; [3]University of Chinese Academy of Sciences

Abstract

The Hangjinqi area in northern Ordos Basin is a significant gas exploration area in China. Although a considerable amount of achievements have been made in natural gas exploration field, the controversy about the hydrocarbon generation characteristics of Shanxi Formation and Taiyuan Formation has raged unabated for ten years and little information has been focused on hydrocarbon expulsion. In this paper, we adopted a comprehensive approach on the evaluation of source rocks. Specifically, we used the rock pyrolysis data, the kerogen composition and biomarker to determine organic matter type and parent material source. Second, we used convolutional neural network (CNN) in the field of depth learning combined with well logging data to calculate total organic carbon (TOC). Third, we used vitrinite reflectance (R_o) and basin simulation model to simulate the thermal evolution history. Then, we used hydrocarbon generation kinetics model to calculate the gas volume and intensity. Finally, we used hydrocarbon generation potential method to calculate the intensity and quantity of hydrocarbon generation and expulsion. The results show that the organic matter type is type III and organic matter comes from algae bacteria and terrestrial plants in weak oxidation-reduction environment. The new method CNN can be used for TOC prediction, and the prediction accuracy is higher than BP neural network and ΔlogR. The predicted high TOC value area is in the middle of the study area. The C29 sterol 20S/(20R+20S) vs ββ/(αα+ββ) diagram indicates that the samples in the southwest are in the mature

stage. Paleogeotemperature in the south of Hangjinqi is higher than that in the north. R_o is 0.8% in the early Cretaceous and 1.2% in the middle Cretaceous. R_o increases from north area to south area. The results of hydrocarbon generation kinetics model indicate that the gas volume of coal of Shanxi Formation and Taiyuan Formations are $8.79 \times 10^{12} m^3$ and $9.50 \times 10^{12} m^3$, respectively, and that of dark mudstone are $0.50 \times 10^{12} m^3$ and $0.70 \times 10^{12} m^3$ respectively. The hydrocarbon generation potential method show that R_o corresponding to the hydrocarbon expulsion threshold of coal seam and mudstone in this area are 1.0% and 0.95%, respectively. The total hydrocarbon generation quantity of coal seam is $18.61 \times 10^9 t$ and that of mudstone is $1.64 \times 10^9 t$, respectively. The source rocks in the Azhen district in the southeast area, Xinzhao district in the southwest area and Shilijiahan district in the central area have higher gas intensity, which is basically consistent with the results calculated by chemical kinetic methods. The total hydrocarbon expulsion quantity of coal seam is $3.07 \times 10^8 t$, and the total mudstone is $0.35 \times 10^8 t$. The intensity of hydrocarbon expulsion gradually decreases from southwest to northeast, and the intensity of hydrocarbon expulsion mainly concentrates in Xinzhao district in southwest area.