

Geochemical Characteristics of Reservoir Bitumen in Jialingjiang Formation in Luzhou Region and Its Significance on Gas Source Indication

HAO CUIGUO, JIN HUI, YANG WEI, LIU WEIHONG

PetroChina Research Institute of Petroleum Exploration & Development, Langfang, China; haocuigu082@163.com

Luzhou paleo-uplift was developed in the south region of Sichuan Basin, China, which is a large-scale inherited paleo-uplift formed during the Indosinian period. In recent years, oil-gas reservoirs in Jialingjiang Formation in Luzhou paleo-uplift has always been a key field for exploration and development of oil & gas fields in Southwest China. Exploration results proved that oil shows were found during the drillings in the core of the paleo-uplift, but the previous researchers have never conducted special studies on the ancient reservoirs in Luzhou paleo-uplift, without evaluations on the crude oil resources in the region yet. This time, through studies on the reservoir bitumen and fluid inclusions, the distribution range of the ancient reservoirs is determined, thus providing a basis for ancient reservoir resources calculation.

In this study, abundant reservoir bitumen was found in the Lower Triassic Jialingjiang Formation. The experimental result of the fluid inclusions shows that most of the GOI values of the Jialingjiang Formation inclusions range from 20% to 30%, and there are phenomena of internal crude oil accumulation, indicating the existence of ancient reservoirs; the current oil and gas are mainly generated from the cracking of crude oil in ancient reservoirs, and the reservoir bitumen solids are the residue of crude oil pyrolysis. Therefore, various geological and geochemical processes experienced after hydrocarbon generation are recorded in the occurrence state, structure composition, and the geochemical characteristics of organic components of the reservoir solid bitumen, and evidence of hydrocarbon sources and accumulation can be provided. Combined with the analysis results of fluid inclusions, the distribution range of paleo-oil reservoirs can be determined, providing a basis for the resource calculation of ancient reservoirs.

Based on the reservoir solid bitumen and hydrocarbon source rock specimen sampled, the methods and techniques of organic petrology, organic geochemistry, and GC-MS are adopted to study the occurrence and genetic types of reservoir solid bitumen in the Jialingjiang Formation. From the aspects of elemental composition, solid carbon isotopes, soluble organic saturated hydrocarbons, etc., the organic geochemical characteristics and gas source indication significance of the reservoir solid bitumen and possible source rocks are discussed. The study shows that the solid bitumen reflectivity in the Jialingjiang Formation reservoirs is high and the dual reflection is obvious, and it is pyrobitumen in reservoirs with heterogeneous structure; as to various pores of carbonate reservoirs, it is vein-shaped, spherical-grained, angular-shaped, or block-shaped and other types of heteromorphic filling, which are characterized by intermediate phase structure and mosaic structure, reflecting the high temperature thermal metamorphism genetic feature; The elemental composition has the characteristics of high S/C and low H/C values. Comparison on the saturated hydrocarbon steric terpene biomarkers in chloroform asphalt "A" shows the rule of sterane, $C_{29} > C_{27} > C_{28}$, and they are of the asymmetrical "V" type. The content of gammacerane is moderate. The hopane test results show that the C_{30} moretane content is low, and the content of C_{29} is lower than that of C_{30} hopane, and it has a single peak shape but no odd-even predominance, which is similar to the characteristics of the Silurian clay source rock biomarker, indicating that it is the product of the peak period of oil production or subsequent product, because the odd-even predominance of hydrocarbons disappears during the peak period of oil production; C_{31} - C_{35} decane does not have the characteristics of the "warping tail" marine carbonate hydrocarbon source rocks. The Jialingjiang Formation itself does not contribute to hydrocarbon generation, which shows that the hydrocarbon in the Jialingjiang Formation along the inner ring area of the edge of Luzhou paleo-uplift mainly came from the Silurian. Even partial natural gas at the edge of the core area shows the characteristics of source rocks or mixed source rocks of the Upper Permian coal series, such as Yanjiaping structure, the liquid hydrocarbons still show they are contributed or mainly contributed by the Silurian hydrocarbon sources. Through analysis on the asphalt under a microscope combined with fluid inclusion distribution range and abundance distribution in Luzhou paleo-uplift and its periphery areas, the distribution range of the ancient reservoirs is clarified, and the distribution area of Jialingjiang ancient reservoirs is eventually determined as 25900km², and the crude oil resources of the ancient reservoirs as 22.56×10⁸m³.

Keywords: ancient reservoir, reservoir bitumen, inclusion, gas source