

**GEOCHEMISTRY AND GENESIS OF BITUMEN IN BIOHERM  
LIMESTONE—AN EVIDENCE OF PALEO-OIL RESERVOIR EVOLUTION,  
NANPANJIANG BASIN, CHINA**

Mengjun ZHAO<sup>1</sup>, Shuichang ZHANG<sup>1</sup>, Lin ZHAO<sup>2</sup> and Jiang DA<sup>1</sup>

*1. Research Institute of Exploration and Development, PetroChina, Beijing 100083, China;*

*2. Guizhou Institute of Petroleum Geology, Southern Petroleum Exploration and Development Corp., Sinopec, Guiyang 550000, China*

The reef paleo-oil reservoir, being special bitumen-rich zone in carbonate rock of Late Palaeozoic, were mainly distributed in Permian and Devonian strata, such as Dachang Devonian paleo-oil reservoir in Nandan County, Anran Permian paleo-oil reservoir in Ronglin County and Banjie Permian paleo-oil reservoir in Ceheng paleo-oil reservoir etc. The reservoir for paleo-oil is mainly bioherm limestone. The bitumen mainly occurs in cavities and fractures, and also in matrix pores and biologic coelomata. Though the study on bitumen reflectance, element analysis, biomarker, and isotope etc, it is thought that the bitumen in paleo-oil reservoir is from mid-lower Devonian source rock in Nanpanjiang Basin and the oil in paleo-oil reservoir cracked under high temperature and pressure in depth into pyrobitumen.

### **1 Geochemical Features of bitumen**

Reflectivity of bitumen. According to bitumen in several typical paleo-oil reservoirs, the bitumen properties are identically characteristic of anthraxolite with high maturity, being fragile, non-dirty, steel-like grey, conchoidally fractured and insoluble in chloroform. The bitumen Rb is 2.85%~6.25% and the corresponding Ro ranges between 2.16%~4.26% with the average of 3.55%.

Elemental analysis of bitumen. The carbon content of bitumen for the Devonian paleo-oil reservoir is 75.2%~87.17% with the mean of 81.5% and the hydrogen to carbon atomic ratio (H/C) is below 0.2. The carbon content of bitumen for the Permian paleo-oil reservoir is 42.5%~86.54% with the mean of 74.9%, and the H/C atomic ratio is about 0.3. These indicate that the evolutionary degree of the Devonian paleo-oil reservoir in Dachang of Nandan County is higher than that of the Permian paleo-oil reservoir.

Carbon isotopes of bitumen. Carbon isotopes for 25 bitumen samples from 5 paleo-oil reservoirs range between -25.9‰~ -29.7‰ with the mean of -27.96‰. Among which carbon isotopes and the average are -25.9‰~ -28.1‰ and -27.33‰ for the Devonian bitumen; -26.5‰~-29.7‰ and -28.1‰ for the Permian bitumen, respectively. These carbon isotopes may also indicate that maturity of the Devonian paleo-oil reservoir is higher.

Dissolubility of bitumen. Extracting soluble compounds from bitumen is one of the methods to understand the origin of bitumen. Bitumen samples from the Nanpanjiang Basin

were extracted with different routine extractions, such as the normal one (using chloroform for 72 h); low-polarity one (using chloroform and normal hexane (1:1) for 72 h) and high-polarity one (using chloroform, methanol and benzene (2:1:1) for 120 h), but no extracted products were obtained even from low-polarity and high-polarity extractions. High maturity of the bitumen is considered to be the main reason for this result.

## **2 Source of the bitumen**

Carbon isotopes for 27 kerogen samples from the Middle Devonian source rock and 12 kerogen samples from the Permian source rock were measured to range between -24.6‰ to -27.6‰ with the mean of 26.6‰ and -22.4‰~-24.7‰ with the mean of -23.6‰, respectively. While carbon isotopes of bitumen from the Devonian and Permian paleo-oil reservoirs vary between -25.9‰~-28.1‰ with the mean of -27.33‰ and -26.5‰~-29.7‰ with the mean of -28.16‰, respectively. Therefore, the bitumen in paleo-oil reservoirs of the studied area was mainly sourced from the Devonian source rock while the Permian paleo-reservoir bitumen shows lower maturity and lighter carbon isotopes due to the mixture with the product generated from the Permian source rock.

## **3 Generation of the Bitumen**

The bitumen related with paleo-oil reservoirs can be generated by reservoir degradation, oil cracking (Huc et al., 2000), bitumen tar formed by hydrocarbons charged at different stages (Wilhelms et al., 1995) and gas invasion bitumen (Littke et al., 1996). Pyrobitumen is greatly different from the bio-degradation bitumen and precipitation asphaltene in maturity and shape. Generally, bio-degradation bitumen and precipitation asphaltene are granularly dispersed and irregular in shape. But pyrobitumen, due to the influence of high pressure, often shows clear marginal polygon.

The bitumen in the Nanpanjiang paleo-oil reservoirs shows a certain geometric shape with clear and straight boundaries, which is accordant with the features of solid bitumen in carbonate reservoirs in the Sichuan Basin (Lin et al., 1998). Furthermore, bitumen in the Nanpanjiang paleo-oil reservoirs has a very high reflectivity, thereby, it is pyrobitumen which was generated by oil carking under the conditions of high temperature and pressure.

## **REFERENCES**

- Lin F, Wang T D, Dai H M, et al. ( 1998 ) The properties and genesis of solid migrabitumen of carbonate reservoirs in Sichuan Basin. *Bull Min Petr Geochem* (in Chinese), 17 ( 3 ) : 174 - 178.