

# **Geologic Factors of Formation of Tight Oil and Its Resource Potential in China\***

**Fuxi Huang<sup>1</sup>, Tao Yang<sup>2</sup>, and Weipeng Yan<sup>2</sup>**

Search and Discovery Article #80306 (2013)

Posted July 31, 2013

\*Adapted from extended abstract prepared in conjunction with poster presentation at AAPG Annual Convention and Exhibition, Pittsburgh, Pennsylvania, May 19-22, 2013, AAPG©2013

<sup>1</sup>Research Institute of Petroleum Exploration & Development, Petrochina. Beijing, 100083, China ([fuxihuang@qq.com](mailto:fuxihuang@qq.com))

<sup>2</sup>Research Institute of Petroleum Exploration & Development, Petrochina. Beijing, 100083, China

## **Introduction**

Tight oil is one of the important unconventional resources, which refers to the oil reservoir that is sandwiched by or adjacent to the tight clastic rock and carbonate rock that contains high quality crude oil, which has not migrated in the massive long distance. Generally the oil reservoir has no natural productivity or its natural yield is low, and large-scale fracturing technology shall be adopted to form an industrial capacity. In the past two years, good exploration results have been achieved in the Jimsar Depression of the Junggar Basin and other key areas. Exploration practices show that five major geological factors are necessary to form the tight oil reservoir. China has rich tight oil resources that is expected to become an important oil superseding resource.

## **Resource Potential and Distribution of Tight Oil of China**

Since 2010, through the exploration principle of Vertical Shaft Controlling the Scale and Horizontal Shaft Increasing the Single Well Production, some favorable exploration results have been obtained in the Erdos, Songliao, Bohai Bay, and Junggar basins, e.g. by fracturing. The daily oil productions of several wells have all reached above 100 cubic meters in the initial stage. Based on the tight oil resource evaluation methods adopted in the foreign countries, preliminary estimated total amount of geological resources of tight oil in China's main basins is more than 10 billion tons. This shows good prospects for the development of China's tight oil.

The tight oil resource distribution in China has four main characteristics:

- (1) Chinese onshore tight oil resources are distributed in the east, central, and west regions, among which the midwest regions have abundant resources, accounting for about 74% of the total amount of geological resources.
- (2) China's tight oil is distributed in Paleozoic to Cenozoic strata, mainly distributed in the sedimentary system of continental lake basins in the Mesozoic and Cenozoic.
- (3) The tight oil resources are mainly distributed in the tight sandstone and carbonate rocks of the lacustrine facies, accounting for 55% and 45% of the amount of resource respectively.

- (4) China's tight oil resources are mainly distributed in the Erdos, Junggar, Song Liao, Bohai Bay, and Sichuan basins and so on ([Figure 1](#)), which are the focus of future exploration.

### **Formation and Enrichment Regularity of Tight Oil**

Exploration practices show that five major geological factors are necessary to form the tight oil reservoir:

- (1) The stable and gentle structure background is a prerequisite to the formation of tight oil, because the broad tectonic and sedimentary environment is conducive to the formation of high-quality hydrocarbon source rock, reservoir area, and cap rocks.
- (2) The high quality hydrocarbon source rocks that are widely distributed are the important material bases for the tight oil formation, because the high quality hydrocarbon source rocks can provide abundant oil and gas resources for all types of oil reservoirs.
- (3) The widely distributed heterogeneous reservoir areas are the fundamental features of tight oil. In the wide and gentle depression and slope area, the broad deposition, thin reservoir, fine granular sediments and diagenesis are the important reasons for the formation of large area tight oil reservoir.
- (4) The integral development of the hydrocarbon source rock and reservoir are the important geological features of the tight oil. Influenced by the stability of relief, tectonic background, sedimentary environment, and sequence filling effect, mutual overlapping development occurs between the effective hydrocarbon source rock and reservoir ([Figure 2](#)).
- (5) The short distance migration of lamellar aggregates is an important feature of tight reservoir formation. Because the large area distribution of the integrated configuration relation between source rock and reservoir rock created favorable conditions for the short distance migration and accumulation of the hydrocarbon.

Controlled by the above-mentioned geological factors, the tight oil has the cookie features that are continuously distributed in large area and locally abundant.

### **Example: Tight Oil of Lucaogou Formation of the Jimsar Depression of the Junggar Basin**

The Jimsar Depression is located in the east of the Junggar Basin, with an area of about 1300 km<sup>2</sup>. The Permian Lucaogou Formation within the depression has the geological factors and distribution features of a tight oil formation. This is the reality region of tight oil field exploration.

The weak structural deformation, undeveloped faults and well-developed direct regional cap rocks in the Jimusar Sag provide a favorable background for the formation of tight oil area. The high abundance hydrocarbon source rocks of mud shale of the Lucaogou Formation (with an average TOC of 3.96%) and its thickness distribution in the whole depression establish the foundation of sufficient resources for the formation of tight oil. The reservoir of dolomitic siltstone and psammitic dolomite that are largely distributed have the properties of low porosity and low permeability. Its average permeability is 0.05 mD, and its average porosity is 8.8%. This provides the reservoir space for the occurrence of crude oil. The integrated configuration relation between source rock and reservoir rock of the Lucaogou Formation, together with two sets of upper and lower dessert bodies with stable thickness, create superior geologic conditions for short distance transport and bedded aggregation of oil and the formation of continuous tight oil areas that have formed a tight oil distribution area of about 900 km<sup>2</sup> and a dessert distribution area of more than 500 km<sup>2</sup>.

## **Conclusions**

Tight oil resource of China is abundant and the focus of future exploration is the Erdos Basin, Junggar Basin, Songliao Basin, Bohai Bay Basin, and Sichuan Basin and so on.

The formation of tight oil is characterized by five geologic factors, including the stable and gentle structural background, the widely distributed high quality hydrocarbon source rocks, heterogeneous reservoir areas, the integral development of the hydrocarbon source rock and reservoir, and the short distance migration of lamellar aggregates.

The tight oil has the cookie features that are continuously distributed in large area and locally abundant.

## **Selected References**

Jia Chengzao, Zou Caineng, Li Jianzhong, et al., 2012, Assessment Criteria, Main Types, Basic Features and Resource Prospects of the Tight Oil in China[J]: Acta Petrolei Sinica, v. 33/3, p. 343-350.

Jia Chengzao, Zheng Min, Zhang Yongfeng, 2012, Unconventional Hydrocarbon Resources in China and the Prospect of Exploration and Development[J]: Petroleum Exploration and Development, v. 39/2, p. 129-136.

Zhao Zhengzhang, Du Jinhu, et al., 2012, Tight Oil & Gas[M], Beijing: Petroleum Industry Press, p. 1-41.

Zou Caineng, Tao Shizhen, Hou Lianhua, et al., 2011, Unconventional Petroleum Geology[M], Beijing: Geological Publishing House, p. 1-93.

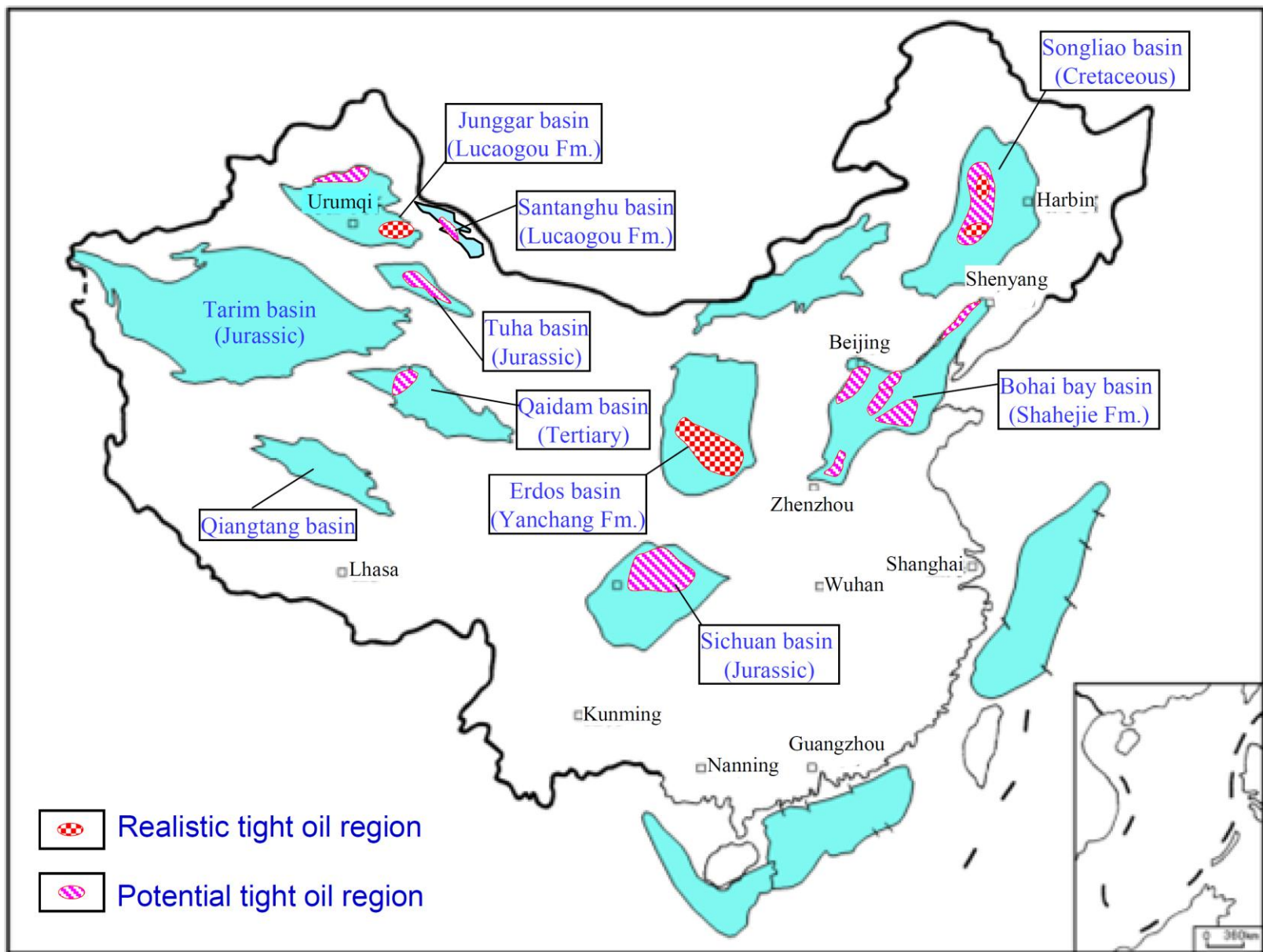


Figure 1. Distribution of the main tight oil basins of China.

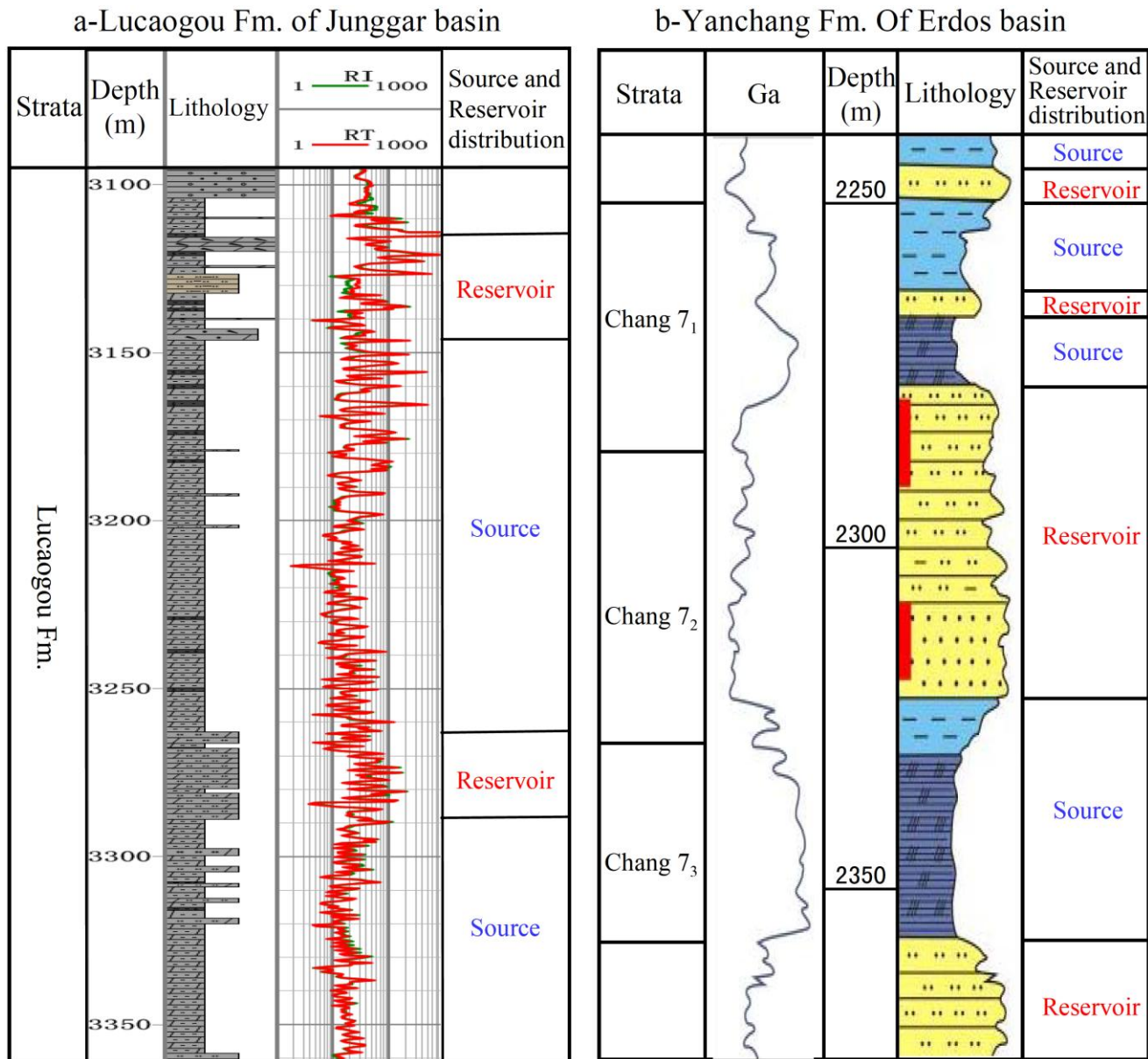


Figure 2. Relationship of source rock and reservoir of tight oil. Junggar and Dedor Basins.