Unconventional Petroleum Geology and Resources in China*

Chenglin Liu¹, Changbo Che², Jie Zhu² and Hulin Yang²

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¹China University of Petroleum, Beijing, China. (liucl@cup.edu.cn)
²Oil and Gas Strategy Research Center of the Ministry of Land and Resources, Beijing, China.

Abstract

The China National Petroleum Assessment (2003-2007) evaluated coalbed methane, oil shale and oil sands resources in Chinese onshore basins. In the geohistory, fourteen-staged coal accumulations (including early Carboniferous, late Carboniferous, and early Permian) formed a large number of coal-bearing basins. In the 42 evaluated basins, coalbed methane resources in place are 37 trillion cubic meters, and recoverable resources are 11 trillion cubic meters. Coalbed methane resources are mainly distributed in the eleven big basins (including the Ordos, Qinshui, and Erlian basin), recoverable resources of which account for 58% of the countrywide resources. Discovered oil shale deposits in China are mainly of lacustrine origins. The oil shale accumulation models were established in deep-water of depressions, shallow-water of rifts, swamps of rifts, and lagoons. Recoverable resources of oil shale are 243.2 billion tons, and recoverable resources of shale oil are 12 billion tons in the 25 evaluated basins. The nine basins (including the Songliao, Ordos, and Lunpola basin) contain more than 100 million tons of recoverable shale oil resources. Several large-scaled tectonic movements formed multiple-phased hydrocarbon generation, accumulation, and reservoir formation, alteration and destruction, which made oil sands distributed in the edges of many basins. In the 24 assessed basins, oil resources in place of oil sand are 6 billion tons, and oil recoverable resources of oil sand are 2.3 billion tons. The seven basins (including the Jungar, Tarim, and Qiangtang Basin), oil in oil sands recoverable resources of which are more than 100 million tons, attain 87.6% of the nationwide resources.

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Chenglin Liu¹, Changbo Che², Jie Zhu², Hulin Yang²

¹ China University of Petroleum, Beijing.
² Strategic Research Center for Oil & Gas Resources of the Ministry of Land and Resources, Beijing.
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1. Introduction


Five types of resources:
- Oil
- Gas
- Coalbed methane
- Oil shale
- Oil sands

Resource category: resources in place, recoverable resources

Formations: lower Paleozoic, upper Paleozoic, Mesozoic, Cenozoic

Depth: coalbed methane (<1500m, and 1500-2000m), oil shale (<100m, and 100-500m), oil sands (<500m, and 500-1000m)

Surface environments: onshore (plain, desert, etc.), offshore

Rank: coalbed methane (Type I, II, III), oil shale and oil sands (ranked by oil contents)
1. Introduction

Evaluation Scope

Five regions:
- Eastern
- Central
- Western
- Southern
- Qinghai-Tibet

Coalbed methane: 42 basins, 121 plays
Oil shale: 80 plays
Oil sands: 24 basins, 106 plays
Coalbed methane resources distribution in China

- Eastern
- Central
- Western
- Qinghai-Tibet
- Southern
- Offshore
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2. Unconventional Petroleum Geology

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4. Unconventional Petroleum Resources
(1) Tectonic evolution and coal accumulation

- Chinese continent is made up of four plates, nine micro-plates, and six orogens. Coal basins are mainly distributed on plates and micro-plates.
- There are 14 coal accumulation periods (including late Carboniferous, early Permian) during Chinese geohistory.
(2) Coalbed methane accumulation conditions

- Tectonic thermal events, effective thickness of overburden formation, and hydraulic energy influence coalbed methane accumulation.

- Stable structures in coal accumulation periods, and weaker tectonic alteration after coal accumulation are favorable for coalbed methane accumulation.

Relationship between depth and gas contents of coal in the Qinshui basin
(1) Oil shale basins in China

- Discovered Oil shale deposits are mainly distributed in larger basins (including the Songliao and Ordos basins).
- Oil shale becomes younger from northwest to southeast in China.
2. Unconventional Petroleum Geology

2.2 Oil shale

(2) Oil shale accumulation models

Deep-water of depressions

Shallow-water of rifts

Swamps of rifts

Lagoons of shelves
## 2. Unconventional Petroleum Geology

### 2.3 Oil sands

#### (1) Two main formation periods (Himalayan, Yanshanian)

Oil sands features and formation periods statistics in China

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<td>Sandy conglomerate</td>
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(2) Model of oil sands formation

- Slope migration model
- Uplift destruction model
- Secondary migration model

Slope migration model at the western Songliao basin

Uplift destruction model at Dongsheng of the Ordos basin

Secondary migration model at Houba of the Sichuan basin
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3. Assessment Methods

(1) Assessment methods

Assessment workflow of coalbed methane plays

- Play 1
- Play 2
- Play 3
- ... 
- Play n

Expert scoring

- Resource richness
- Resources in place
- Recoverable resources
- Resource type
- Alteration of coalbeds
- Market demand
- Terrain conditions
- Pipeline construction

× Weight value

Resources and their recoverability

× Weight value

Exploitation conditions

× Weight value

Score of coalbed methane plays

Assessment methods

- Volumetric methods
- Analog methods
- Play comprehensive assessment methods
3. Assessment Methods

Parameters of coalbed methane

Key parameters of coalbed methane

- Recovery ratio
  \[ R = \frac{C_i - C_a}{C_i} \]
  \[ R = 1 - \frac{V_L \cdot P_a}{C_i (P_L + P_a)} \]

- Gas content of coalbeds
  - Test
  - Analog
- Depth of Weathering zone of methane
  - Extrapolation
  - Relationship of methane concentration and depth
    - Analog

- Resource type
  - I, II, and III type
- Comprehensive assessment parameters
  - Resources and their recoverability
  - Exploitation conditions
3. Assessment Methods

(2) Assessment parameters

Parameters of oil shale

- Recovery ratio
  - Key parameters of oil shale
  - The average value: 75%

- Oil yield ratio
  - Oil content
    - Cutoff: 3.5%

- Area of oil shale

- Thickness of oil shale
  - Geological parameters
  - Comprehensive assessment parameters
    - Development parameters
Parameters of oil sands

(2) Assessment parameters

- Recovery ratio: 0.2~0.85
- Oil content: Extraction method
- Area of oil sands
- Thickness of oil sands
- Comprehensive assessment parameters
3. Assessment Methods

(3) Assessment software and database system
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Coalbed methane resources in place are 37 trillion cubic meters, and recoverable resources are 11 trillion cubic meters.

Region distribution of coalbed methane resources in China
4. Unconventional Petroleum Resources

Oil shale resources

**Oil shale**

- Resources in place: $7199 \times 10^8$ tons
- Recoverable resources: $2432 \times 10^8$ tons

**Shale oil**

- Resources in place: $476 \times 10^8$ tons
- Recoverable resources: $120 \times 10^8$ tons
Oil shale resources distribution in China
(3) Oil sands

Oil sands resources

Oil resources in place of oil sand are 6 billion tons, and oil recoverable resources of oil sand are 2.3 billion tons.

Depth distribution of oil resources in place of oil sands resources in China
Oil sands resources distribution in China
Coalbed methane, shale oil, and oil of Oil sands resources distribution in China

4. Unconventional Petroleum Resources

(5) Production forecast of unconventional petroleum

- Oil of oil sands
- Shale oil
- Coalbed methane

Year:
- 2005
- 2010
- 2015
- 2020
- 2025
- 2030

10^6 tons

10^8 cubic meters
Thanks!