

# 15<sup>th</sup> U.S. - China Oil & Gas Industry Forum

History and prospect of continental facial oil  
and gas resource development in China



**CNPC, HE Jiangchuan**

**September, 2015**

# Introduction



The development of oil and gas resources in China has made a remarkable history since 1950s.

Annual production rises from **0.07** MMT of oil in 1949 to **209.8** MMT of oil and **132.9** BCM of gas in 2014, which is supporting the rapid growth of Chinese economy continuously.

# Outline



**1. Resource Characteristics**

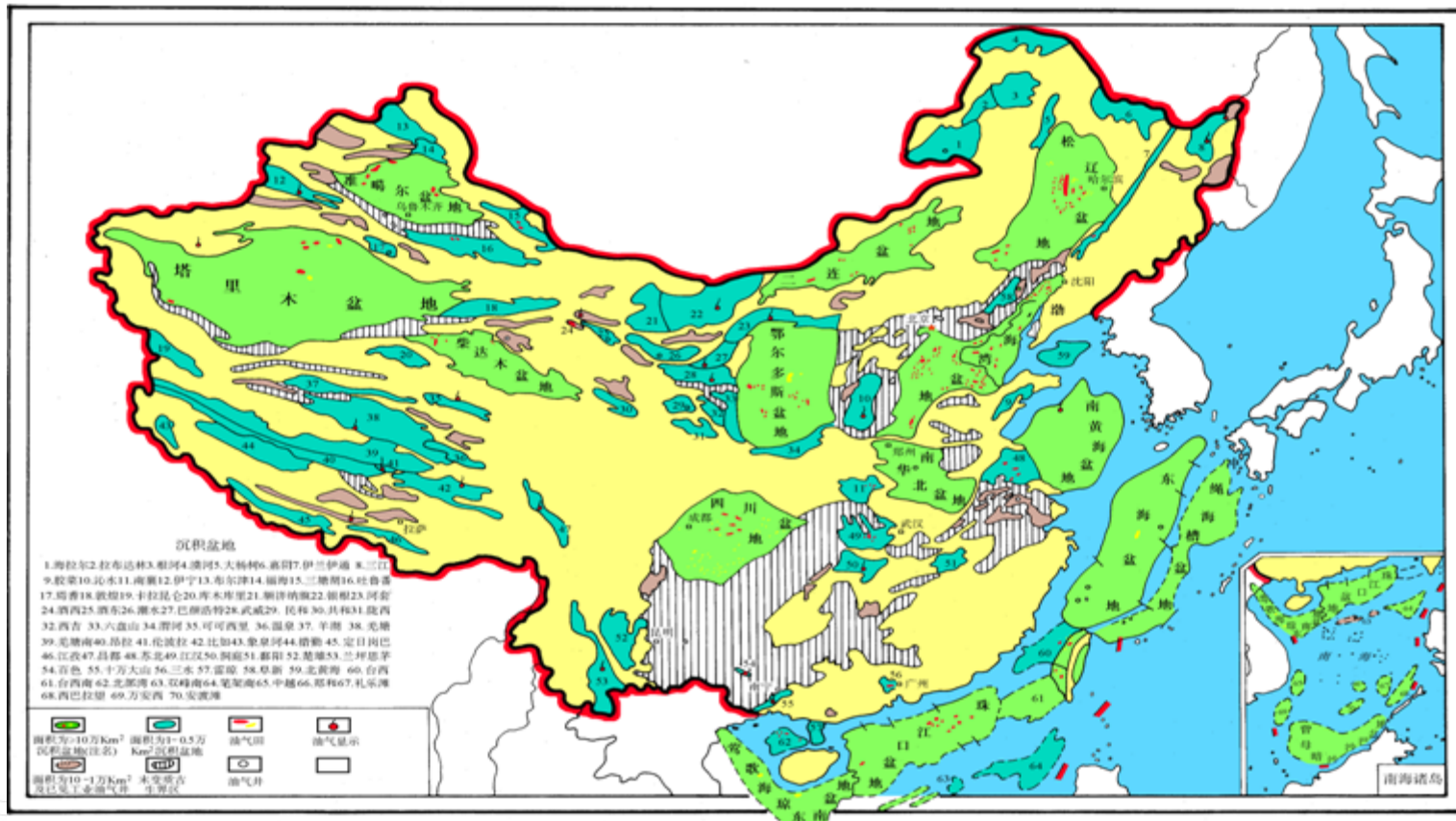
**2. Development History**

**3. Prospect Forecast**

# ➤ Resource Characteristics



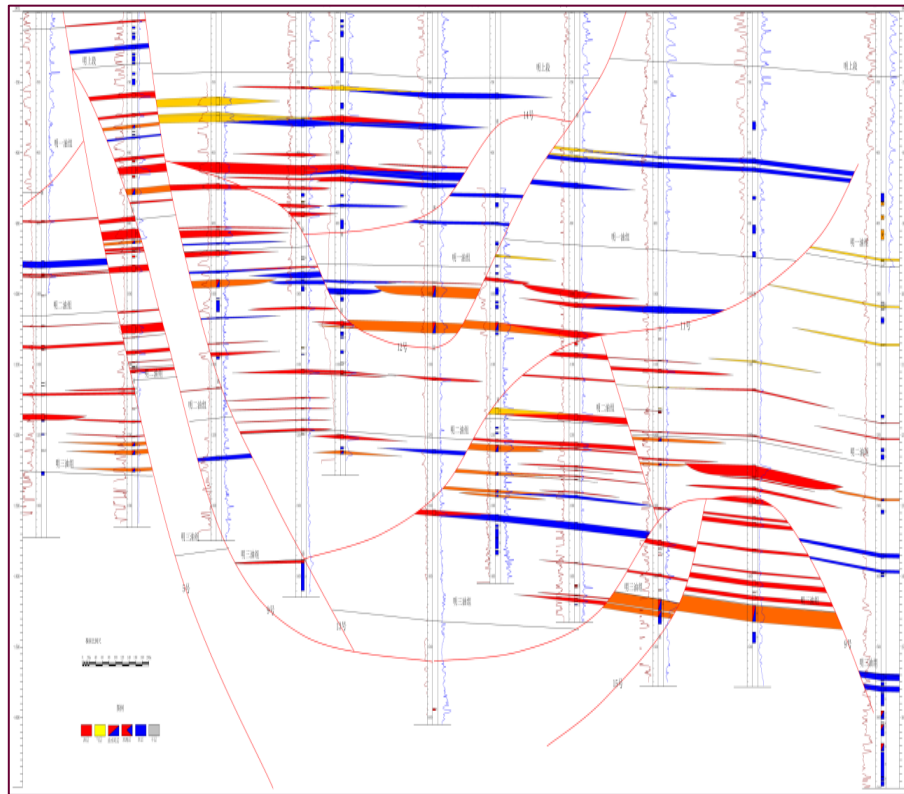
	Resource	OOIP	Ratio
Crude Oil	108.5 BMT	36 BMT	33%
Natural Gas	68 TCM	12 TCM	18%



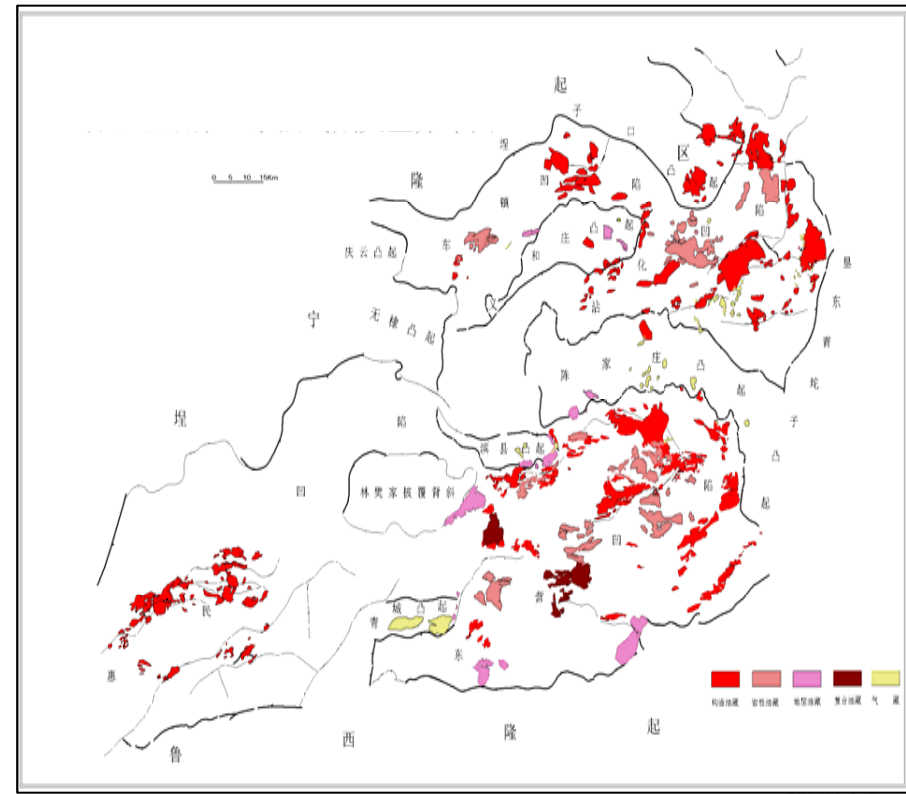
# ➤ Resource Characteristics



- ❑ Rich in faults and small blocks
- ❑ Great differences in distribution of oil and gas



**HUANG HUA depression profile  
(Dagang Oilfield)**

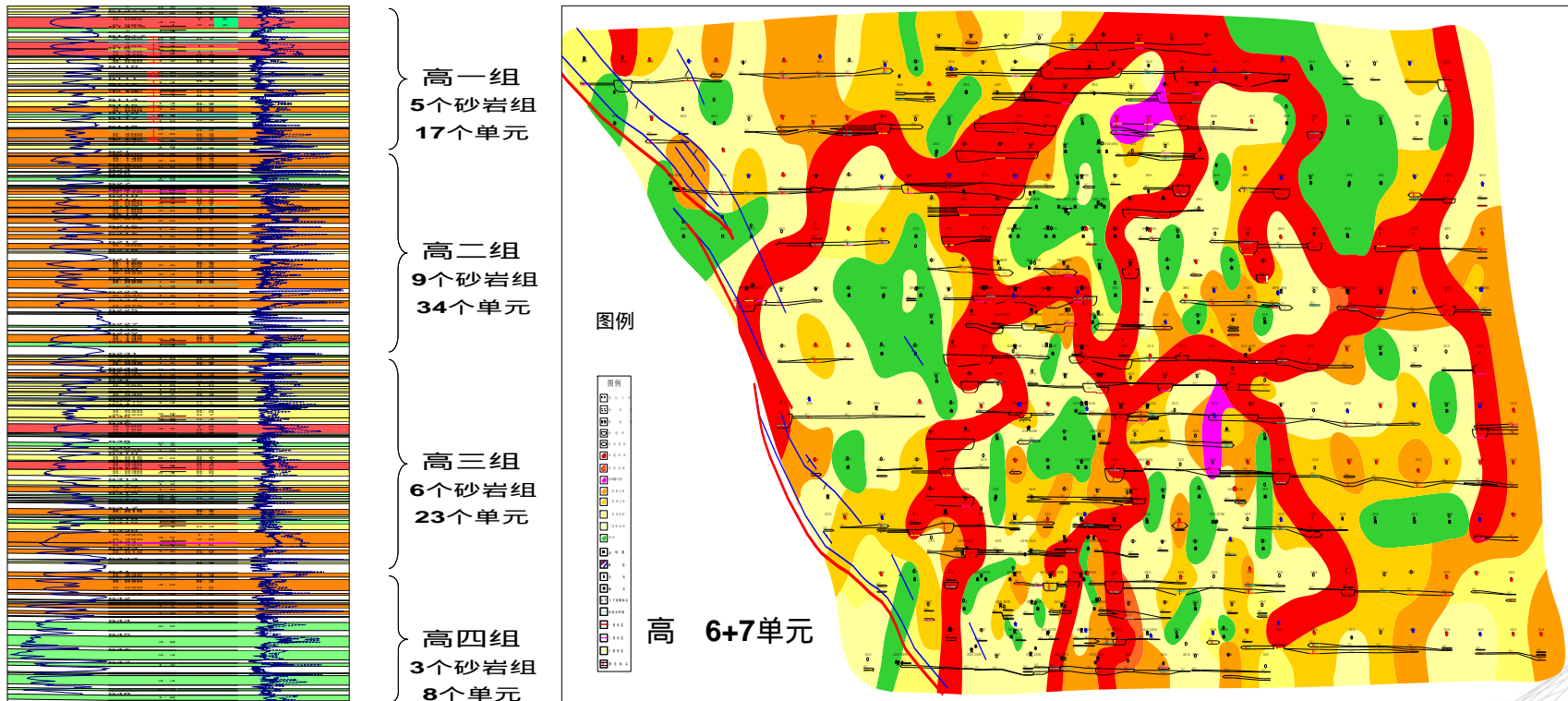


**JI YANG depression horizontal distribution  
(Shengli Oilfield)**

# ➤ Resource Characteristics



- ❑ Frequently transformed sedimentary facies
- ❑ Small sand body and limited connectivity
- ❑ Thin layers with different characteristics



**GAO TAI ZI sand profile, Daqing**  
23 sand layers and 82 deposition units

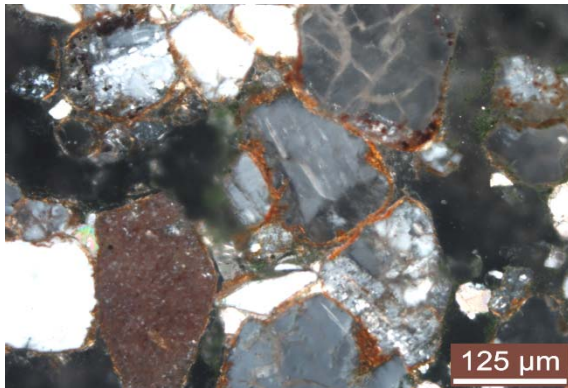
**GAO TAI ZI sedimentary facies, Daqing**  
frequent transformation and low connectivity

# ➤ Resource Characteristics

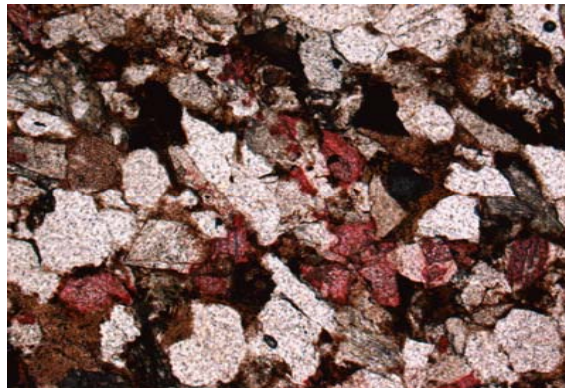


- **Microstructure:** poor sorting, complicated pore structures, developed microcrack, low porosity and permeability

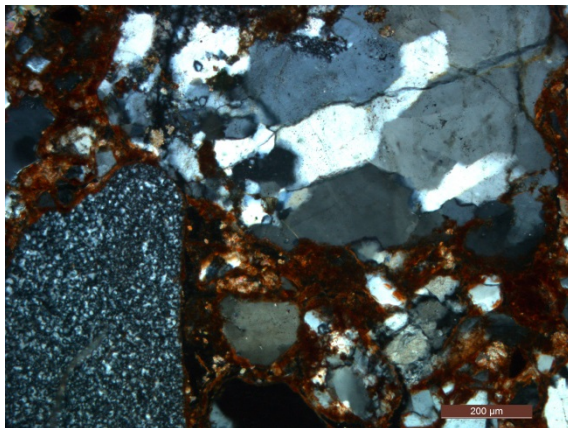
**Daqing oilfield**  
500-1200mD



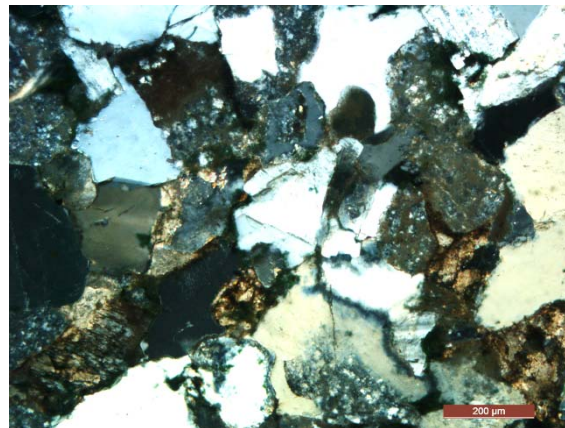
**Changqing oilfield**  
0.3-5mD



**Xinjiang oilfield**  
100-500mD



**Jilin oilfield**  
1-30mD



## ➤ Resource Characteristics



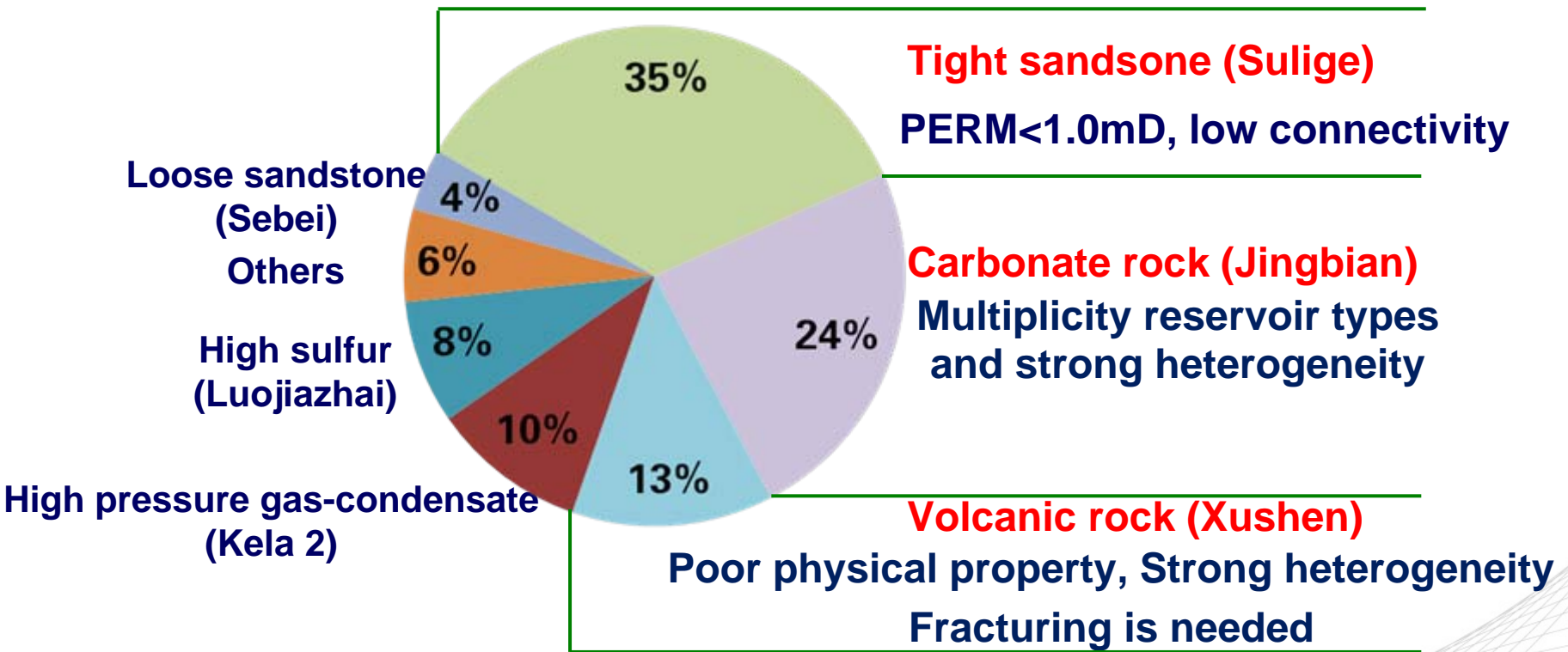
- ❑ Large ratio of kerogen and humus, high paraffin content, high freezing point and high viscosity
- ❑  $\text{NaHCO}_3$  type brine, low salinity

Oilfield	Paraffin, %	Freezing point,	Density	API	Viscosity, 50
DA QING	28.7	30	0.857	32.8	23.79
LIAO HE	13.5	31	0.885	27.7	52.3
SHENG LI	7.0	28	0.946	17.5	498.0
DA GANG	26.1	33	0.882	28.2	854.2
YU MEN	8.3	15.5	0.853	33.0	12.9
XIN JIANG	6.8	10	0.857	32.8	15.05

# ➤ Resource Characteristics



- Tight sandstone, carbonate, and volcanic rock contribute major gas reservoirs, characterized by complicated pore structure and strong heterogeneity



Distribution of proved gas reserves

# Outline



**1. Resource Characteristics**

**2. Development History**

**3. Prospect Forecast**

# ➤ History



## 1. Early age : Before 1949

- ❑ 29 MMT of OOIP, 33 wells and 70,000 tons of annual output
- ❑ 390 MCM of OGIP and 10 MCM of accumulated output



**Miaoli Oil Bureau, 1878**



**Official petroleum factory in Yanchang, 1905**



**Laojunmiao Oilfield in Yumen, 1939**



## 2. Production recovering (1949~1958)

- ❑ Central and western China: Qinghai, Karamay, Sichuan gasfield discovered
- ❑ Theory of continental oil source improved
- ❑ 147,000 tons of oil production in 1958



Sichuan Gasfield, 1950



Qinghai Lenghu  
Oilfield, 1954



Karamay Oilfield, 1955



## 3. Fast development (1959~1978)

- ❑ Eastern China: Daqing, Shengli, Liaohe and Zhongyuan oilfield discovered
- ❑ Theory of continental oil source confirmed; E&P techniques developed
- ❑ Annual oil production climbed to 100 MMT in 1978



**Daqing, 1959-Songji 3 well**



**Shengli, 1961-Hua 8 well**



**Liaohe, 1966-Liao 6 well**



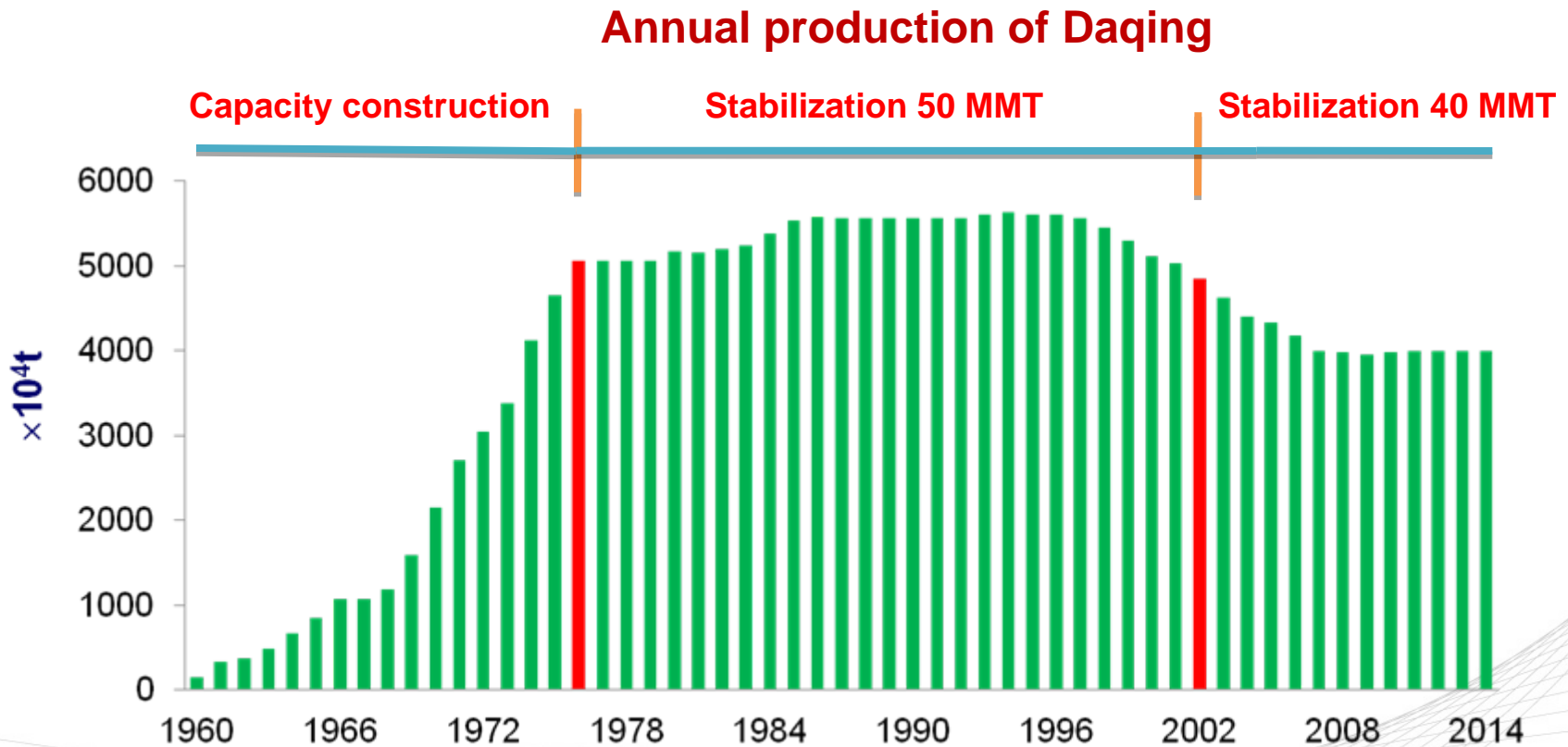
**Huabei, 1975-Ren 4 well**





## 3. Fast development (1959~1978)

The annual production of Daqing Oilfield reached 50 MMT in 1976, kept stable for 27 years. Production had accumulated 2.2 BMT until 2014





## 4. Production stabilization (1978~1998)

- ❑ Stabilize east and develop Tarim, Tuha and Tahe oilfield in western China
- ❑ Water cut control for matured fields and gas production technologies
- ❑ Annual oil/gas production: 160 MMT/23.3 BCM in 1998

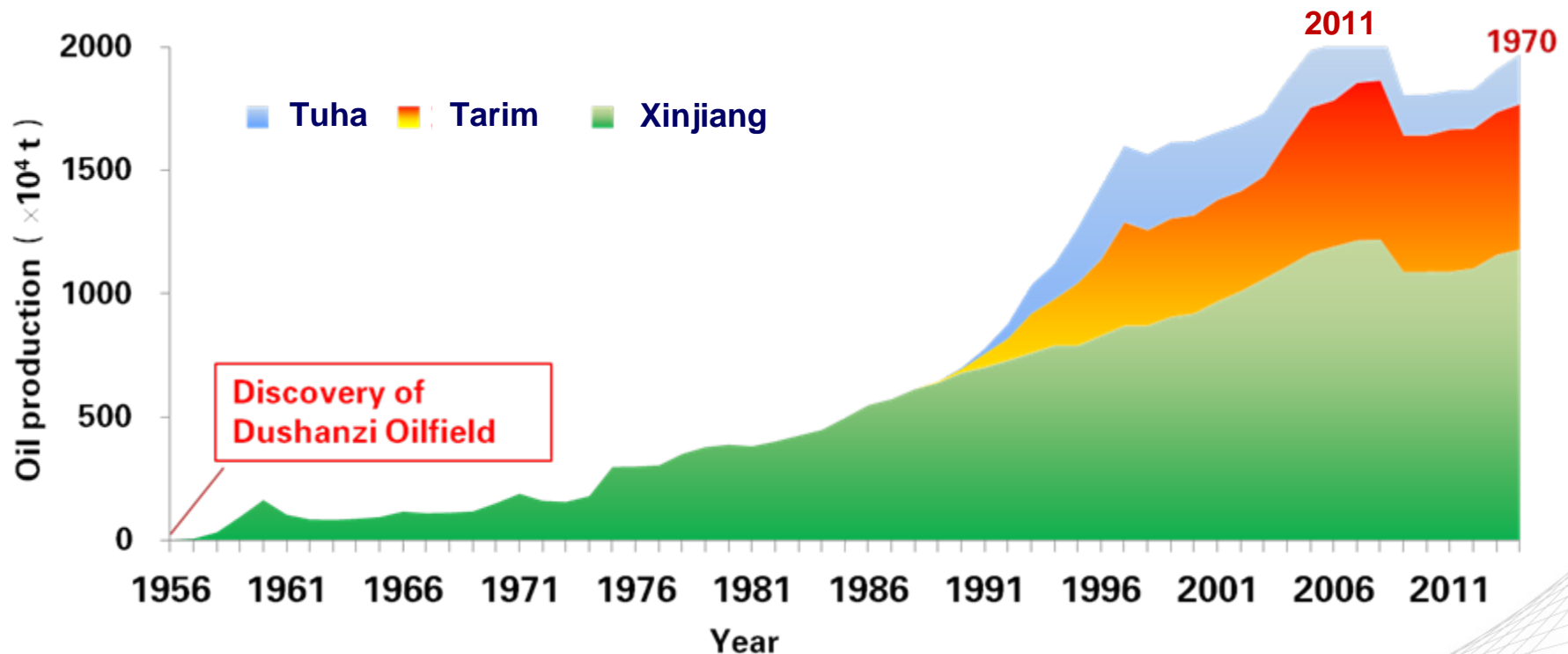


**Tarim, 1989—Lunnan 2 well**   **Tuha, 1991—Taican 1 well**   **Tahe, 1997—Sha 48 well**



## 4. Production stabilization (1978~1998)

- ❑ Three major oilfields of CNPC in Xinjiang developed rapidly
- ❑ Annual oil output rose from 3.53 MMT in 1978 to 15.66 MMT in 1998

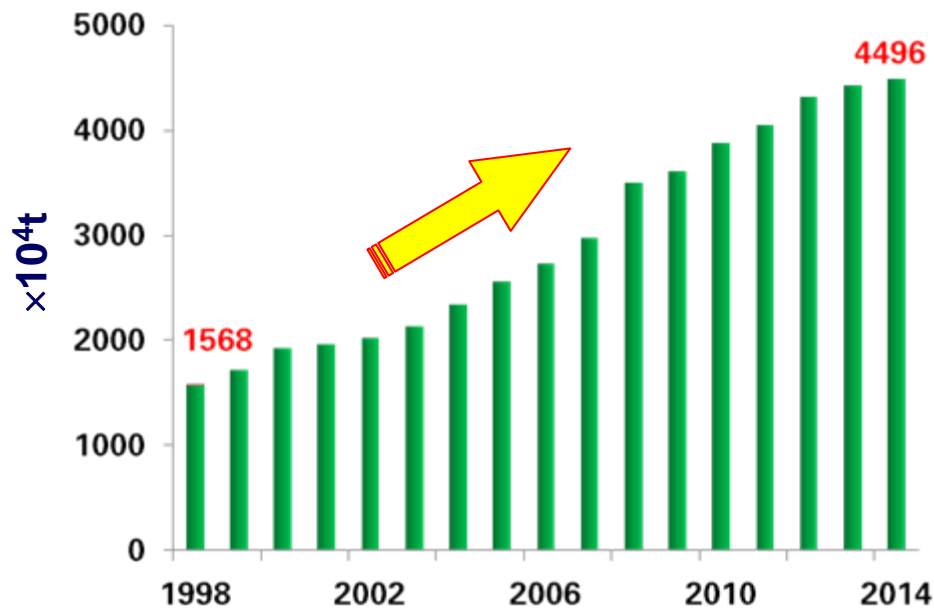


Oil production of three basins in Xinjiang

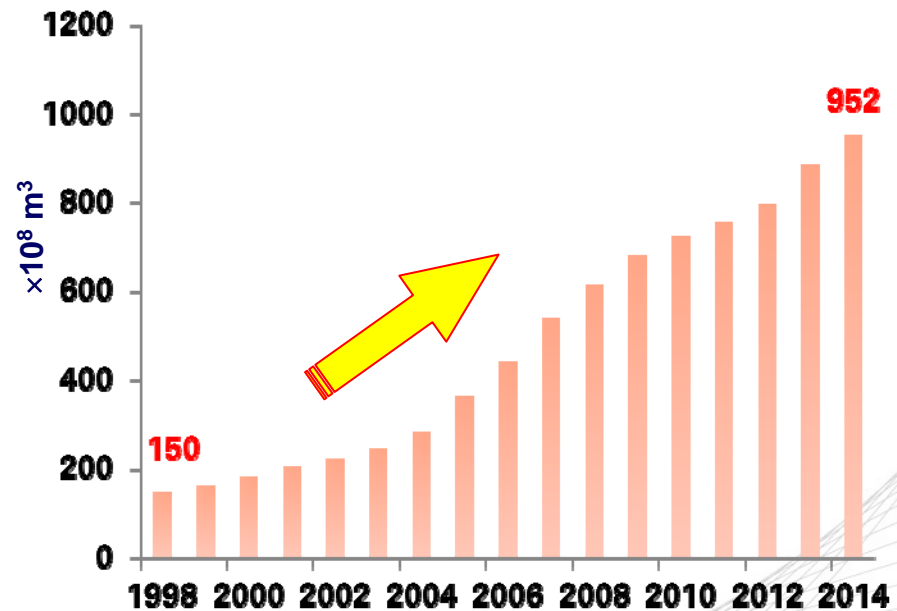


## 5. Area expanding (since 1998)

- ❑ Technology innovation for unrecoverable reserves, matured oilfields and gasfields
- ❑ Ultra-low permeability reservoirs: lower limit extends from 5mD to 0.3mD.
- ❑ Changqing oilfield became a major oilfield producing 50 MMT oil and gas equivalent
- ❑ Annual oil production of EOR reached 34 MMT in 2014



Annual oil production in low-permeability reservoirs of CNPC



Annual gas production of CNPC

## ➤ Current status



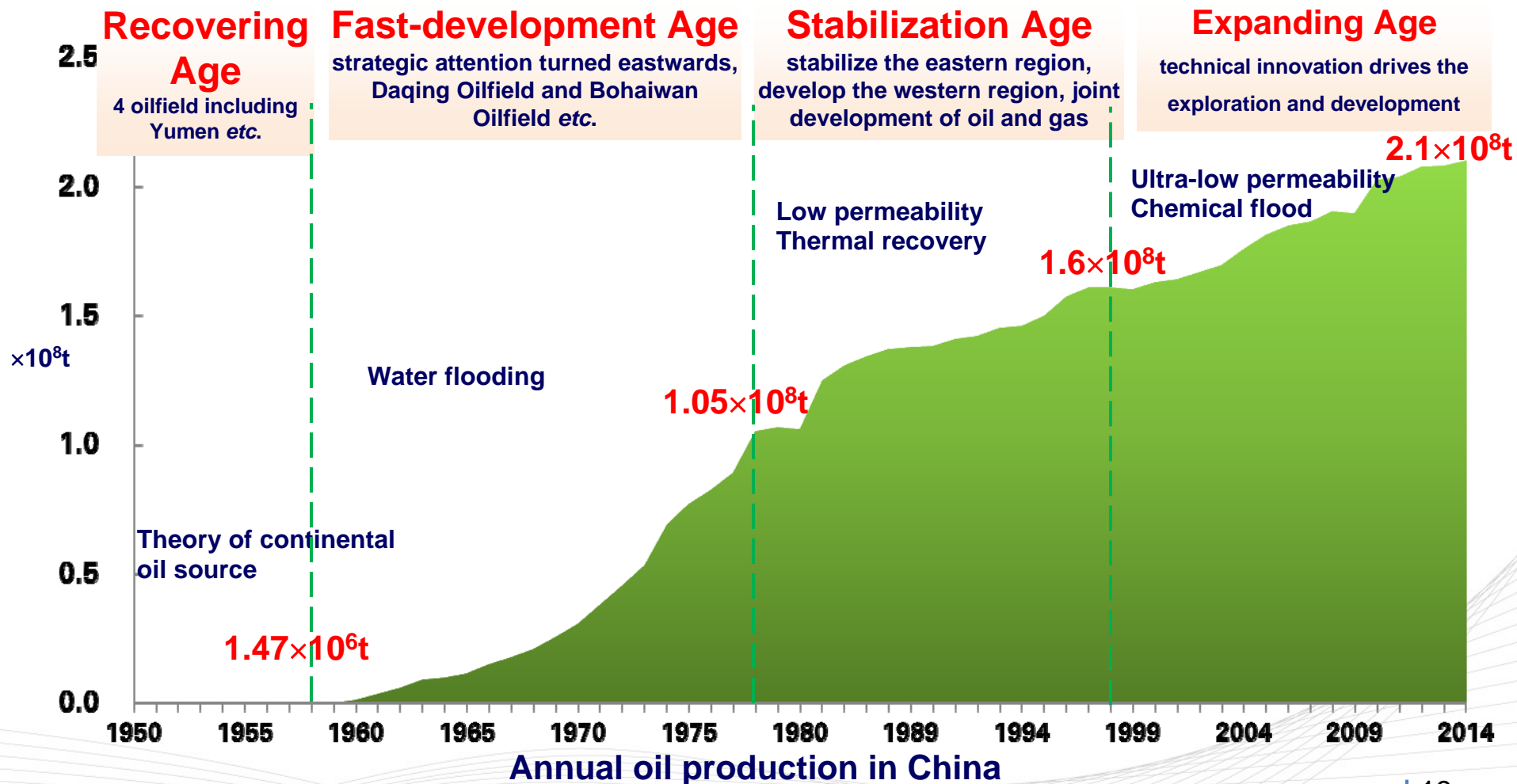
❑ By 2014, 27 oil and gas producing bases have been established



## ➤ Current status



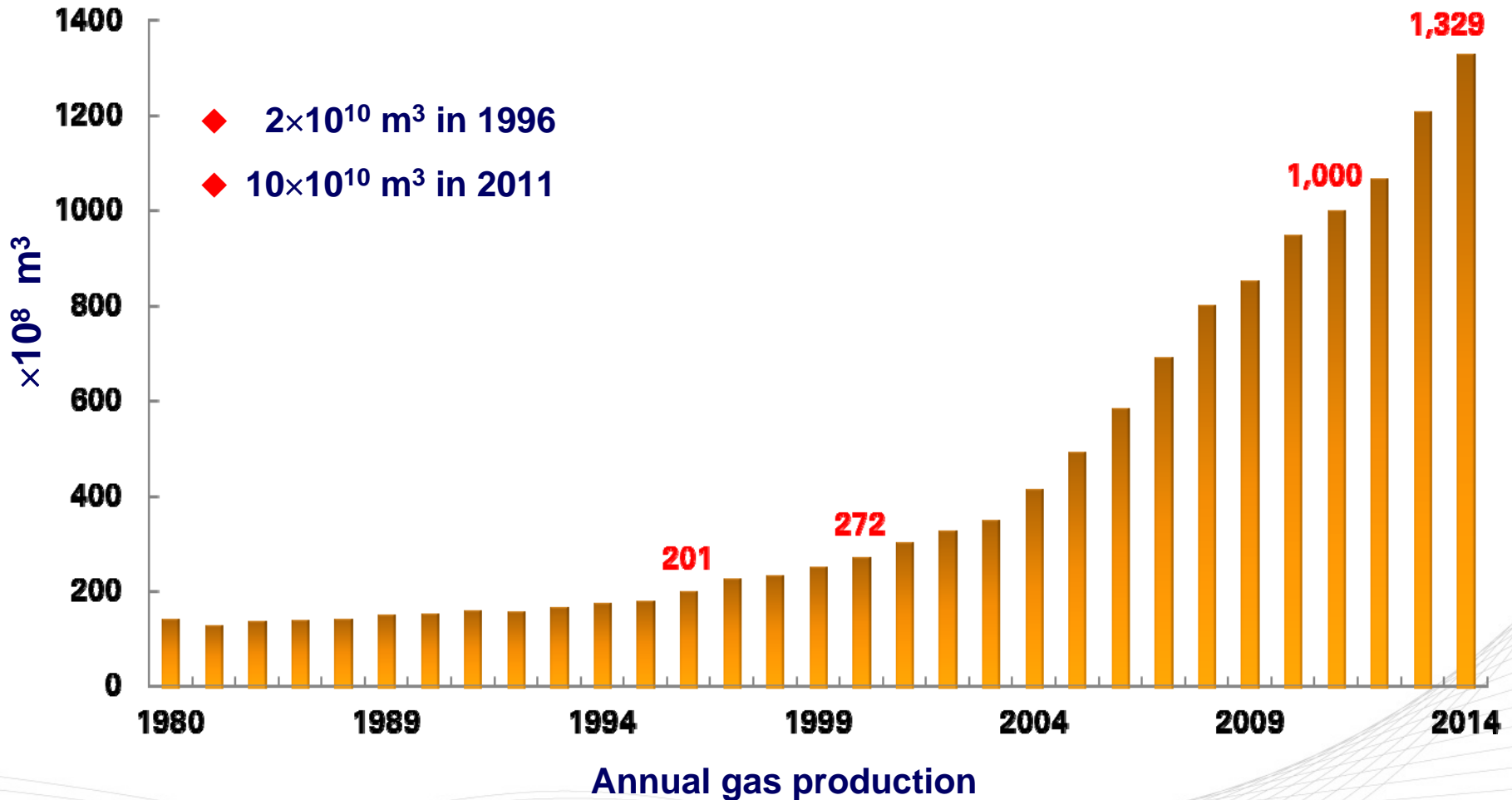
- ❑ Annual oil production 209.8 MMT in 2014, ranking the 4<sup>th</sup> in the world
- ❑ Kept more than 200 MMT for five years



## ➤ Current status



□ Annual gas production grows from 27.2 BCM in 2000 to 132.9 BCM in 2014



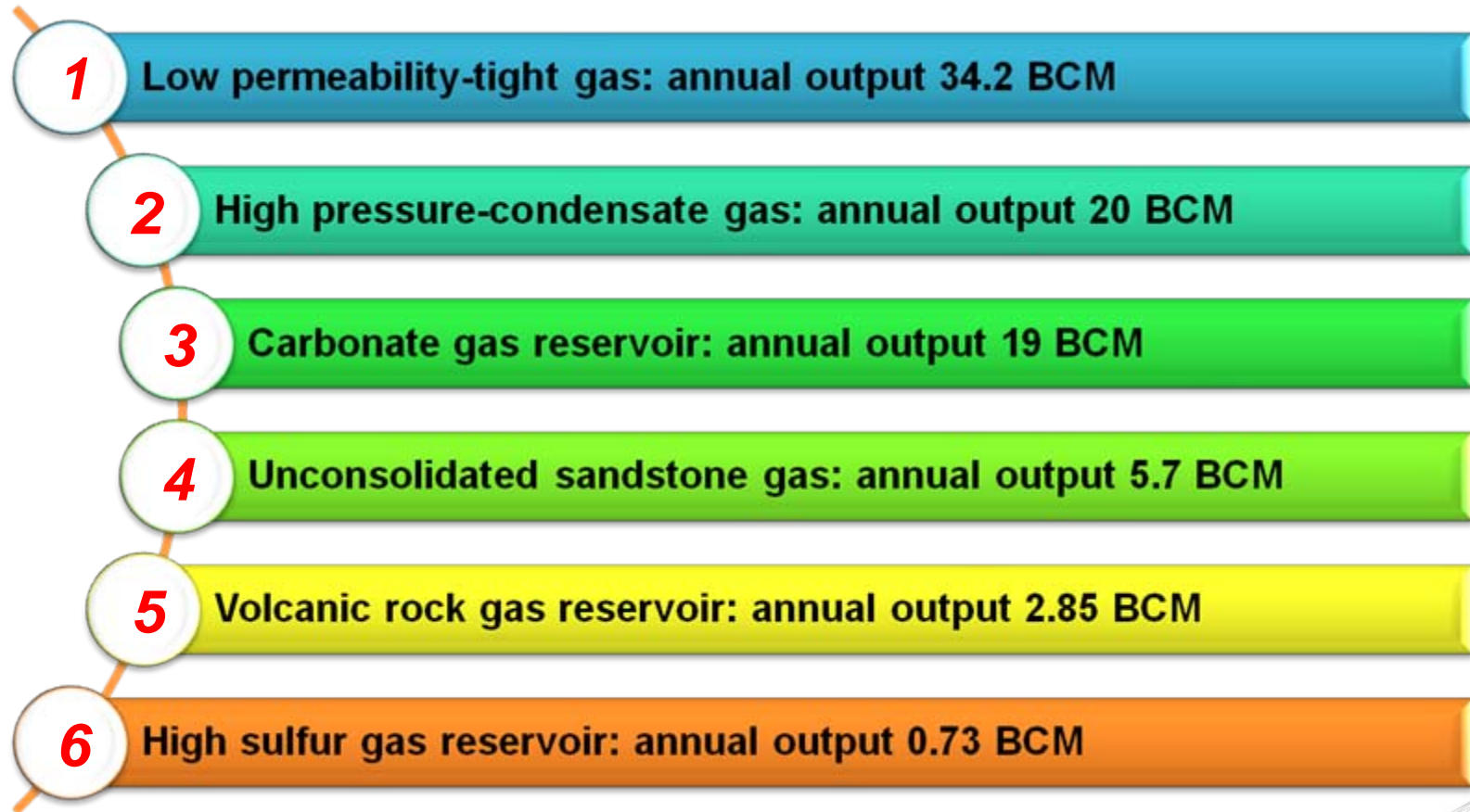


## ❑ Oilfield development technologies

- 1 Continental sedimentation theory: proven reserve 32 BMT
- 2 Fine water injection: recovery 33%, annual output 106 MMT
- 3 Chemical flooding: recovery 10–25%, annual output 18 MMT
- 4 Thermal recovery: recovery 30%, annual output 14 MMT
- 5 Low permeability recovery: recovery 25%, annual output 71 MMT
- 6 Tight oil recovery: annual output 1 MMT



## □ Gas field development technologies



# Outline



**1. Resource Characteristics**

**2. Development History**

**3. Prospect Forecast**



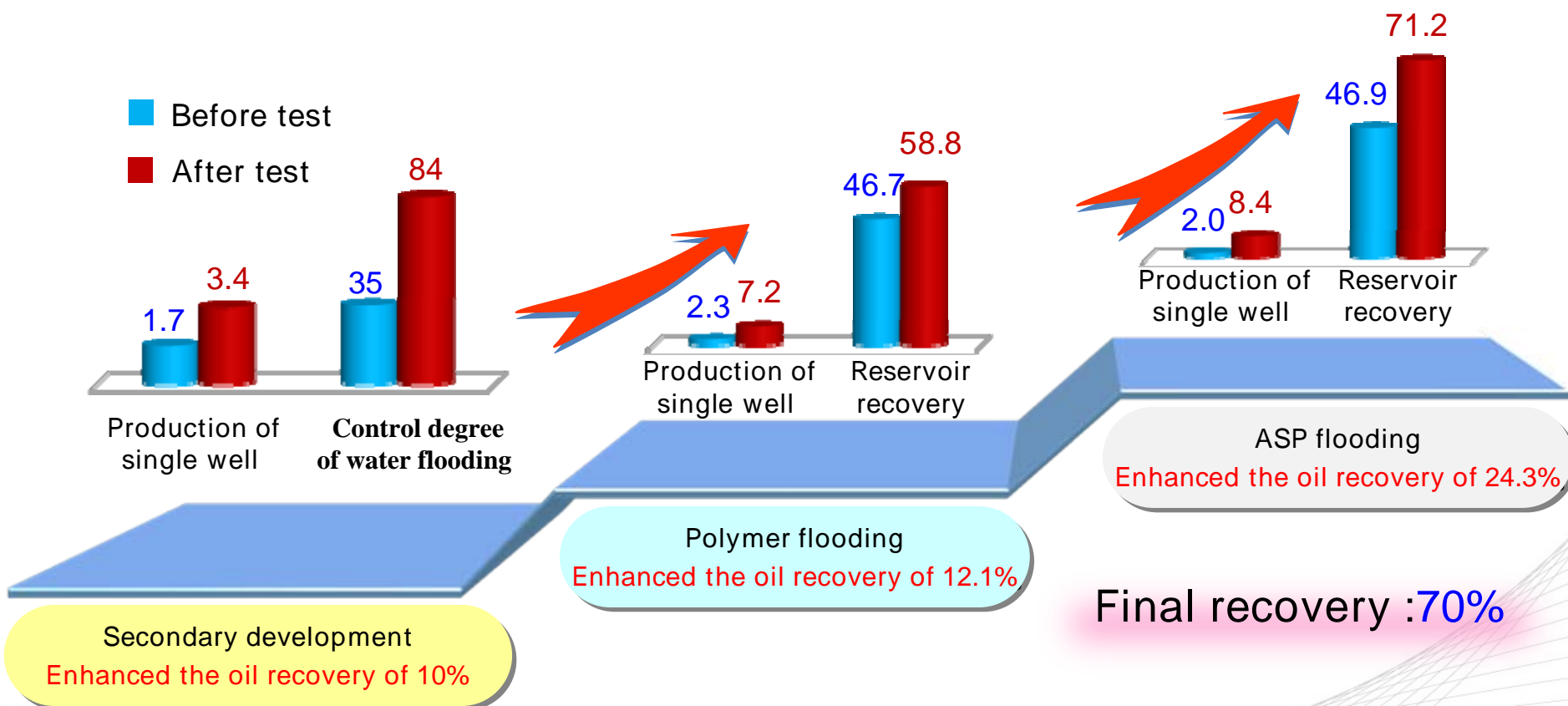
**Different with the countries with high quality resources , China is now facing two challenges: continental facial sedimentation and high water cut.**

**Technology innovation is the only way to make this breakthrough, whenever in history or in future, as was proved in the revolution of tight oil and shale gas by US.**

# ➤ Improve recovery of matured fields



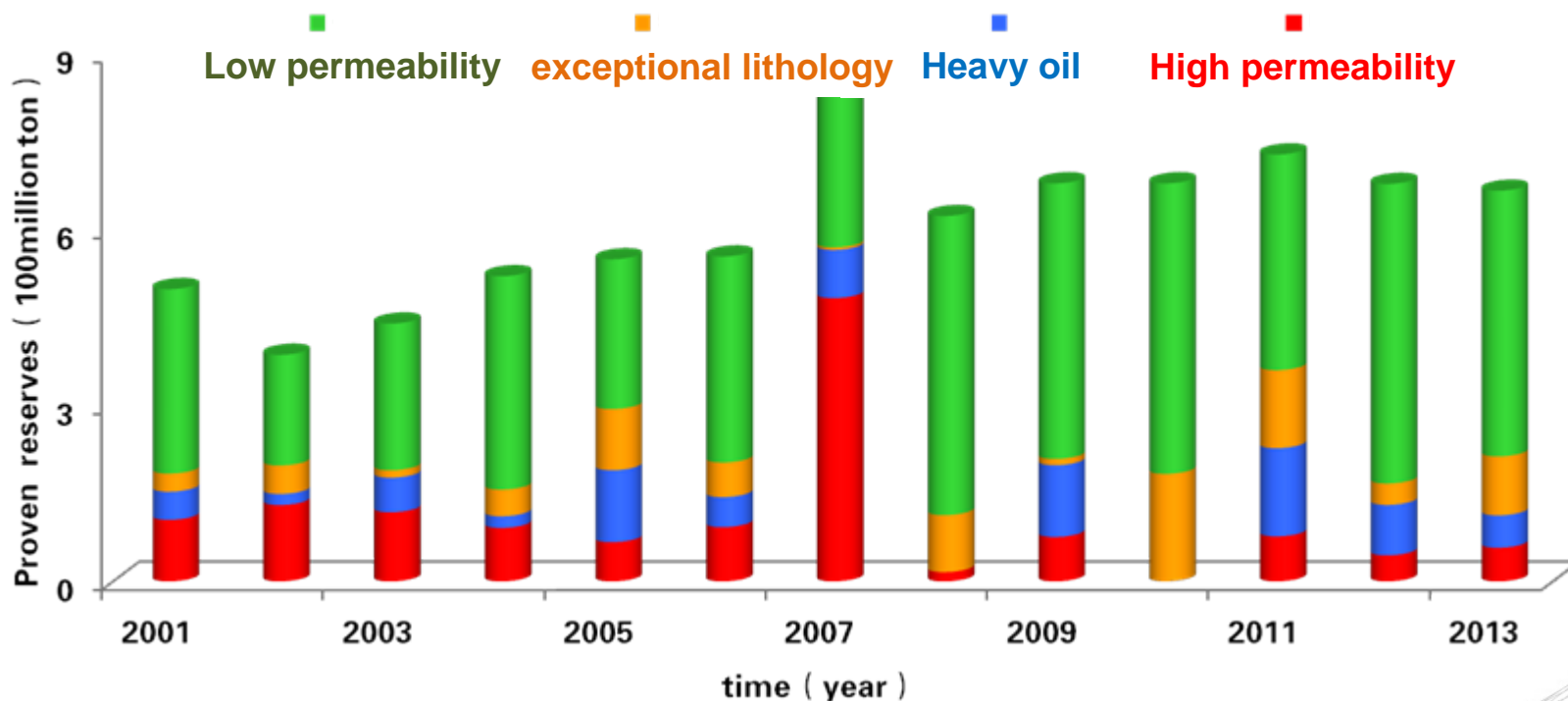
□ Fine water injection and chemical flooding has been developed which increases recoverable reserves by 900 MMT



## ➤ Profit improvement for low permeability oilfield



- ❑ As the major resource, development of low permeability reservoirs is facing dual challenges technically and economically under low oil price

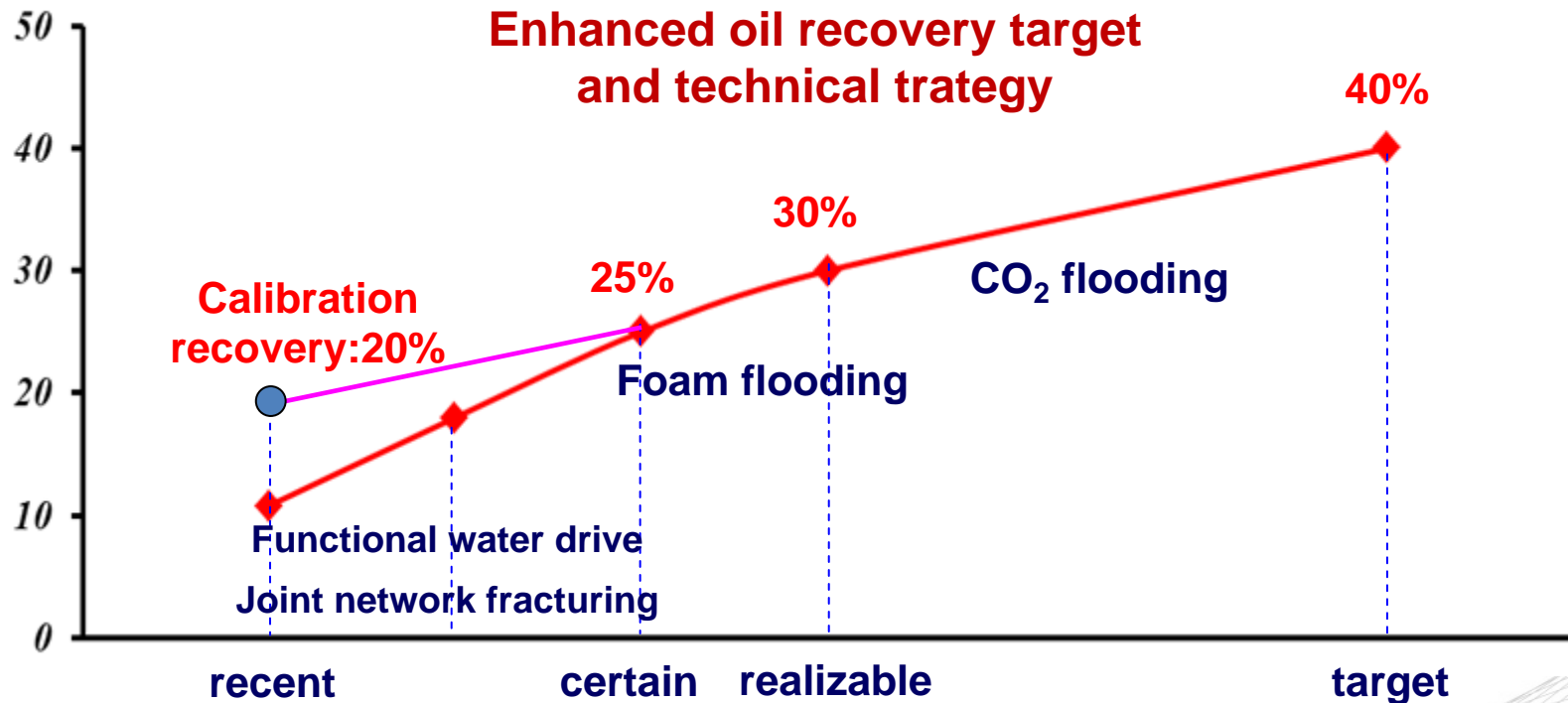


OOIP of CNPC since 2001

## ➤ Profit improvement for low permeability oilfield



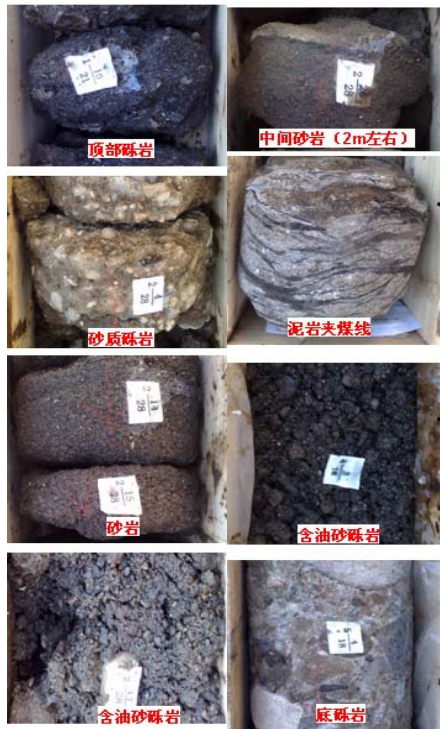
- CNPC is focus on functional water flooding, volume fracturing and CO<sub>2</sub> flooding for low permeability oilfields, by which 500 MMT more recoverable reserve is expected



## ➤ Cost cut for heavy oil



- CNPC is focus on multi-medium steam flooding, SAGD, in-situ combustion, expecting to increase recoverable reserves by 257 MMT

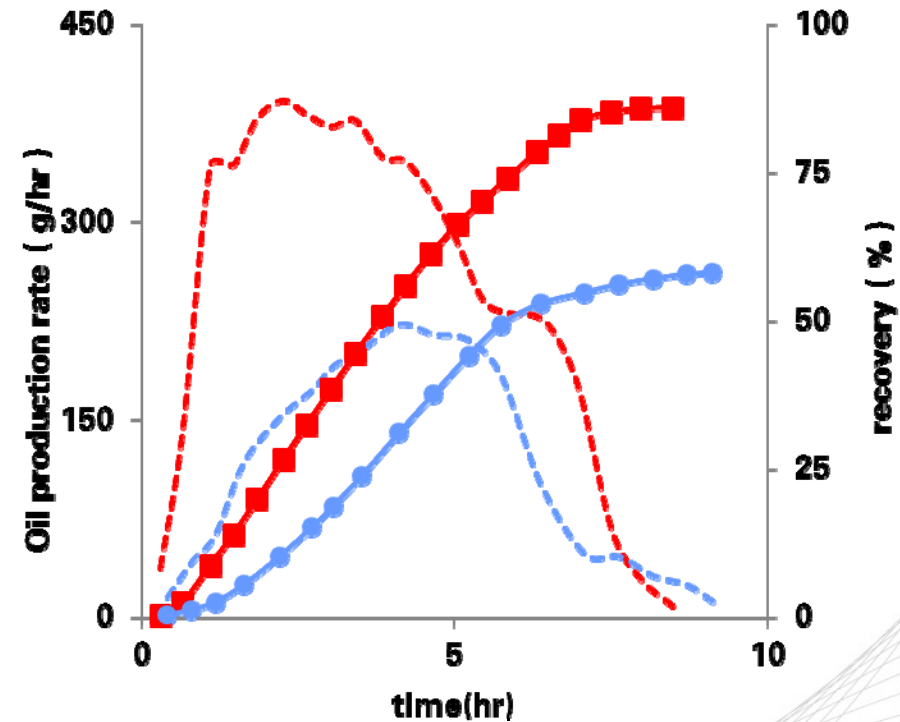


core photos before fire flooding



Core oil saturation below 3%

core photos of h2118A well  
after fire flooding

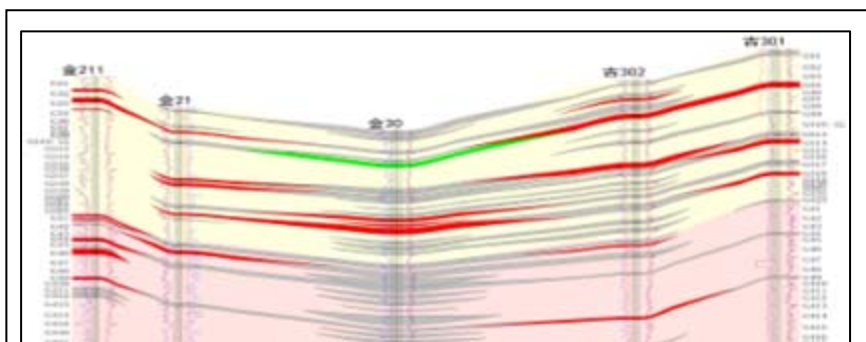


Development effect of auxiliary solvent SAGD

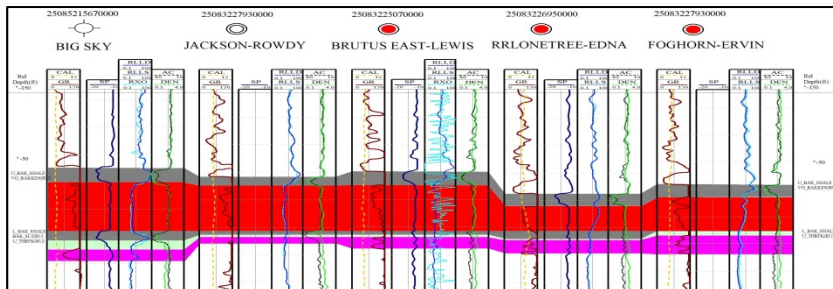
# ➤ Tight oil development



- ❑ Tight oil resource in China is about 47.6 BMT, which is thin, low porosity, low mobility and relatively poor oil properties, compared with that in north America



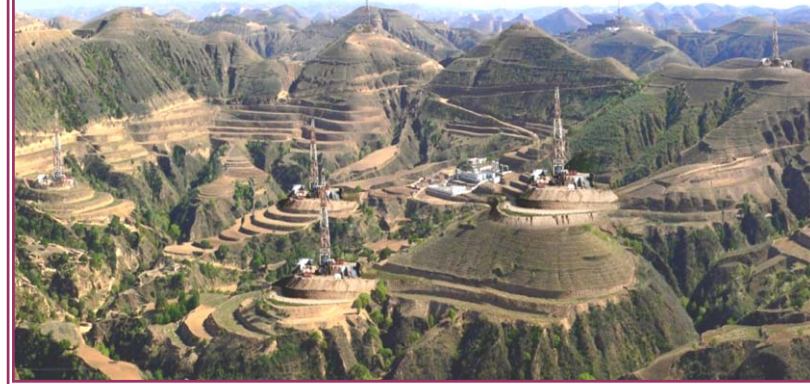
**Continental tight sandstone oil:** thin reservoir thickness, poor continuity, low abundance



**Marine tight sandstone oil:** reservoir thickness, good continuity, high abundance

Comparison between continental and marine tight sandstone reservoir profile

**Western China**



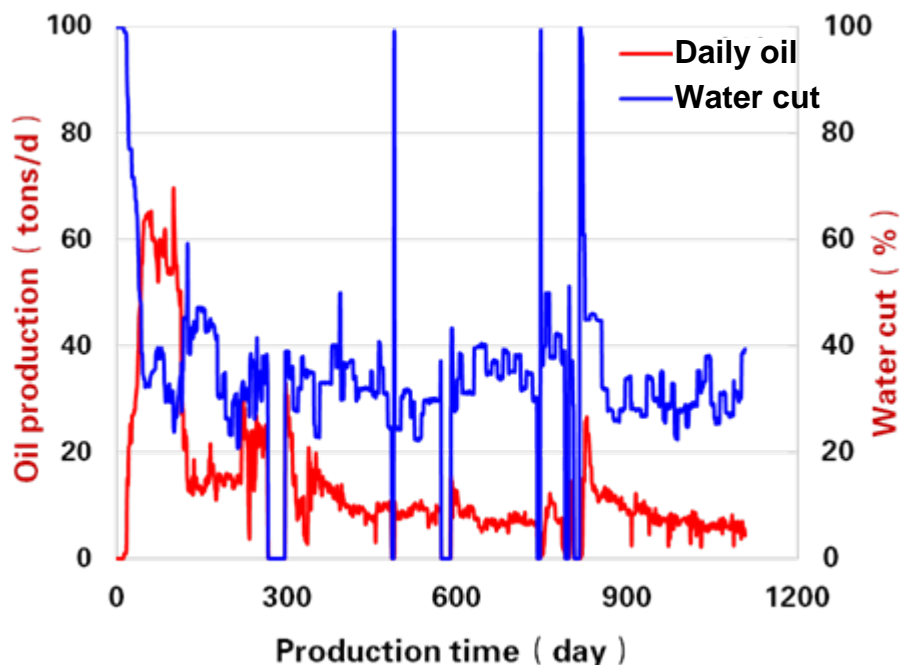
**Northern America**



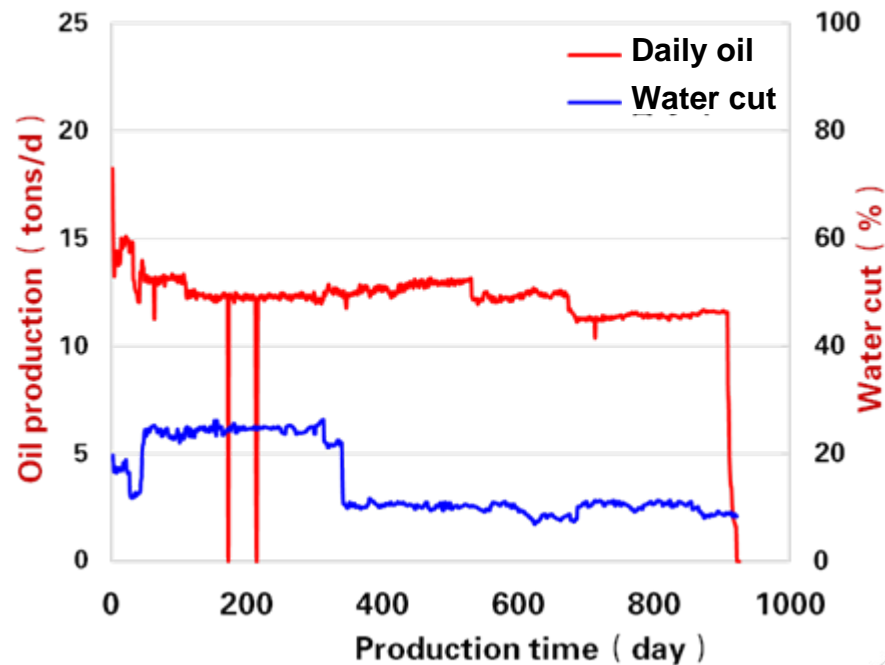
## ➤ Tight oil development



- The annual production in 2014 climbs to 1 MMT with the support of resource recognition, volume fracturing and equipment



Xinjiang Ji 172H Well , water cut: 40%,  
stage oil production: 14,400 tons



Changqing Yangping 8 Well , water cut: 9%,  
stage oil production: 11,200 tons



# Thank you