KUALA LUMPUR 2012 WORLD GAS CONFERENCE

25th world gas conference

"Gas: Sustaining Future Global Growth"

New Progresses of Natural Gas Exploration Practice and New Recognition on Resource Potential in China

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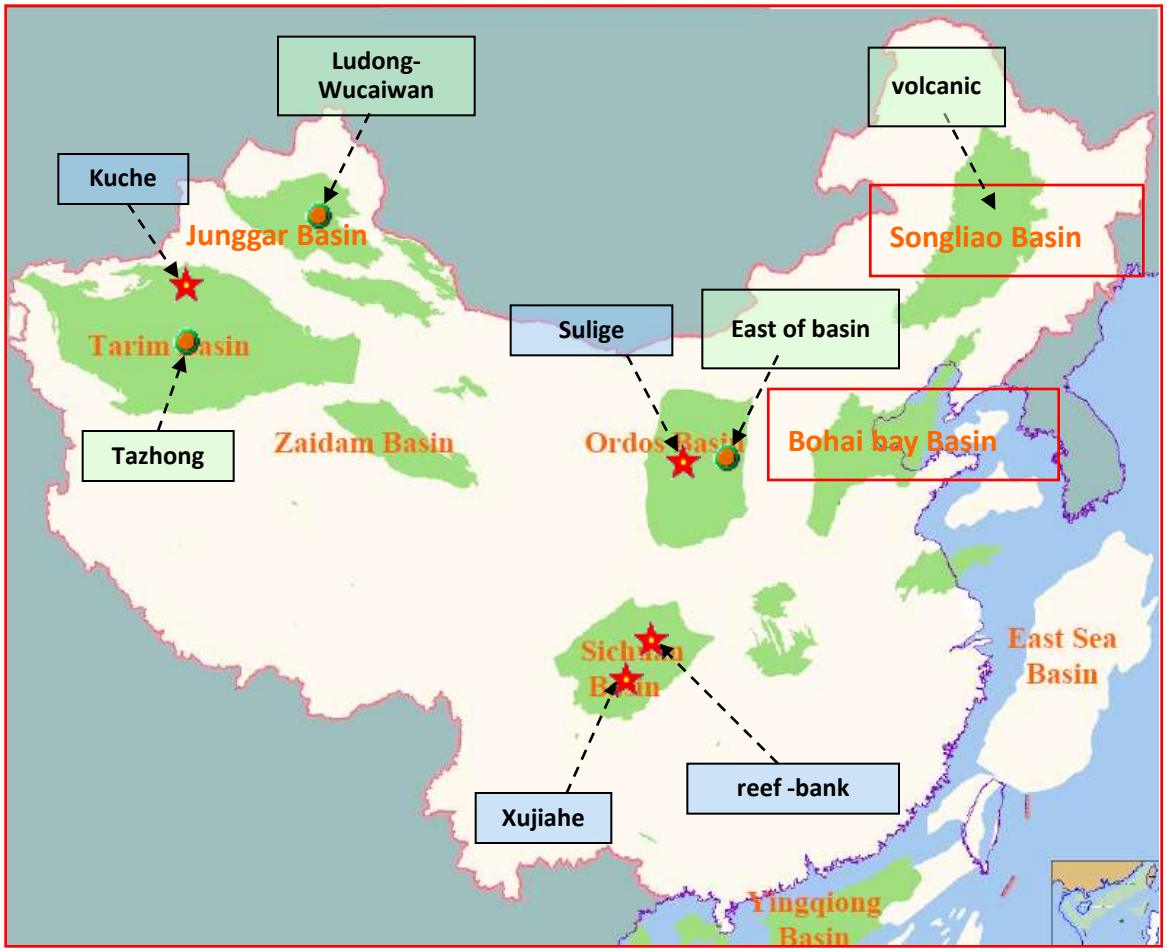
Outline

1. New progresses on natural gas exploration of CNPC
2. New knowledge on geological theory of natural gas in China
3. Re-evaluation of the potential natural gas resources of CNPC
4. Conclusions

(1) Significant progresses

- Natural gas reservoirs discovered



- ✓ **CNPC made major discoveries in Ordos, Sichuan, Tarim, Songliao and Junggar Basin**
- ✓ **Breakthroughs in 6 areas:**
  - ☐ Carbonate reservoir
  - ☐ Thrust belt reservoir
  - ☐ Litho-stratigraphic reservoir
  - ☐ Volcanic reservoir
  - ☐ Biogenic gas
  - ☐ Unconventional

(1) Significant progresses

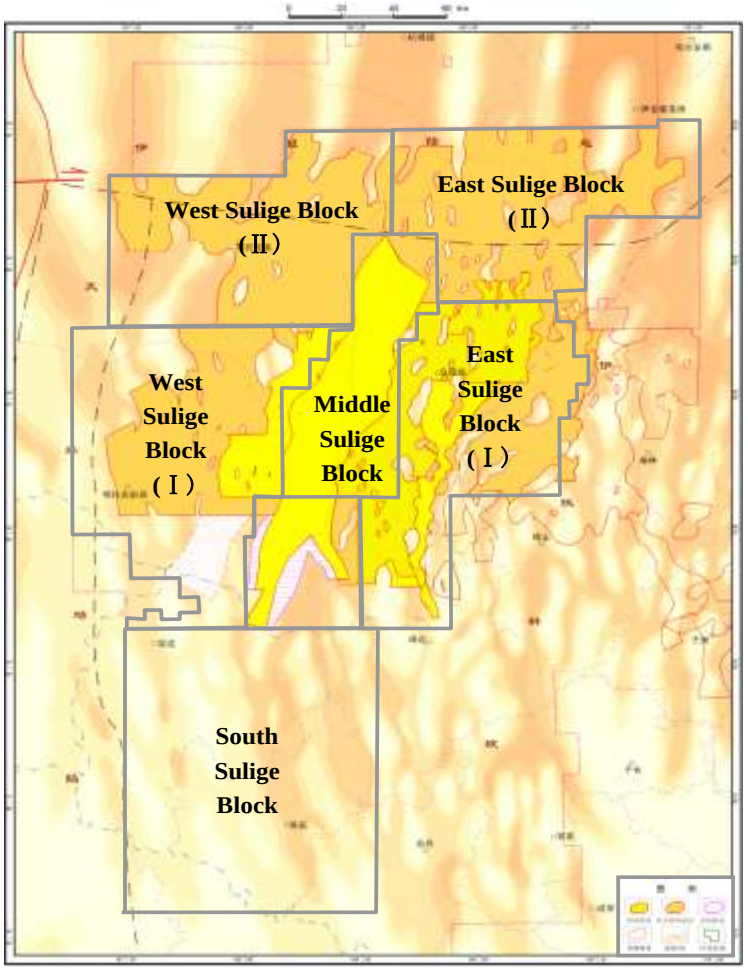
- Most important discoveries in six key exploration areas

Exploration domain	Gas field	Discovery	Formation	Proved reserve (BCM)	Percentage(%)
Carbonate	Weiyuan	1964	Z	40.9	25
	Wubaiti	1989	C	54.0	
	Jingbian	1989	O	470.0	
	Dukouhe	1995	T	35.9	
Foreland	Kela-2	1998	E	284.0	11.8
Litho-stratigraphic	Sulige	2000	C-P	1100.0	45.8
Volcanic	Xushen	2002	K	202.1	8.4
Biogenic gas	Sebei- Ⅰ	1964	Q	99.1	4.1
Unconventional	Qinshui	1997	C	115.2	4.8

Note: Reserve until to the end of 2010; Production in 2010

(1) Significant progresses

① Sulige gas field of Ordos basin

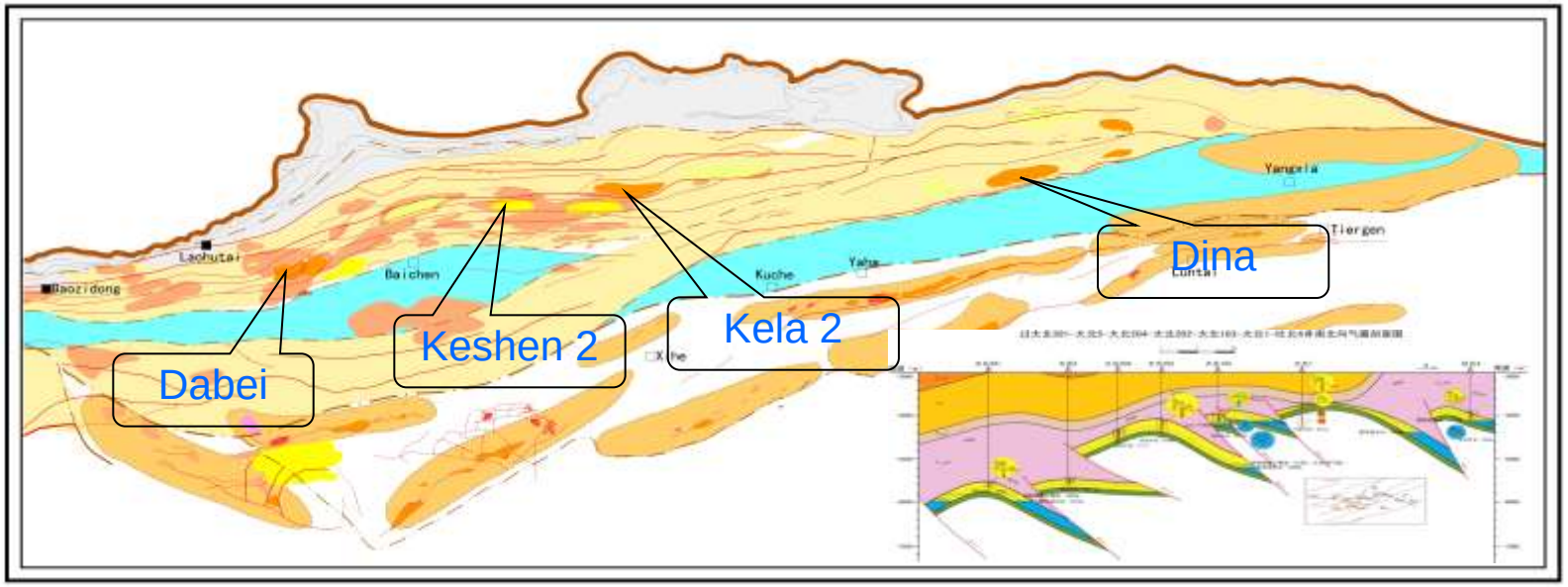


China's largest gas field

- Potential area: 40000km^2
- Discovery: Su-6 with a daily output of 1.2 mcm in 2000
- Proven gas in place by 2010: 1.1tcm
- Resources: 3.8tcm
- Types: large-scale litho-stratigraphic reservoirs
- Characteristics: low permeability, low pressure and low abundance

(1) Significant progresses

② Kuche depression of Tarim basin



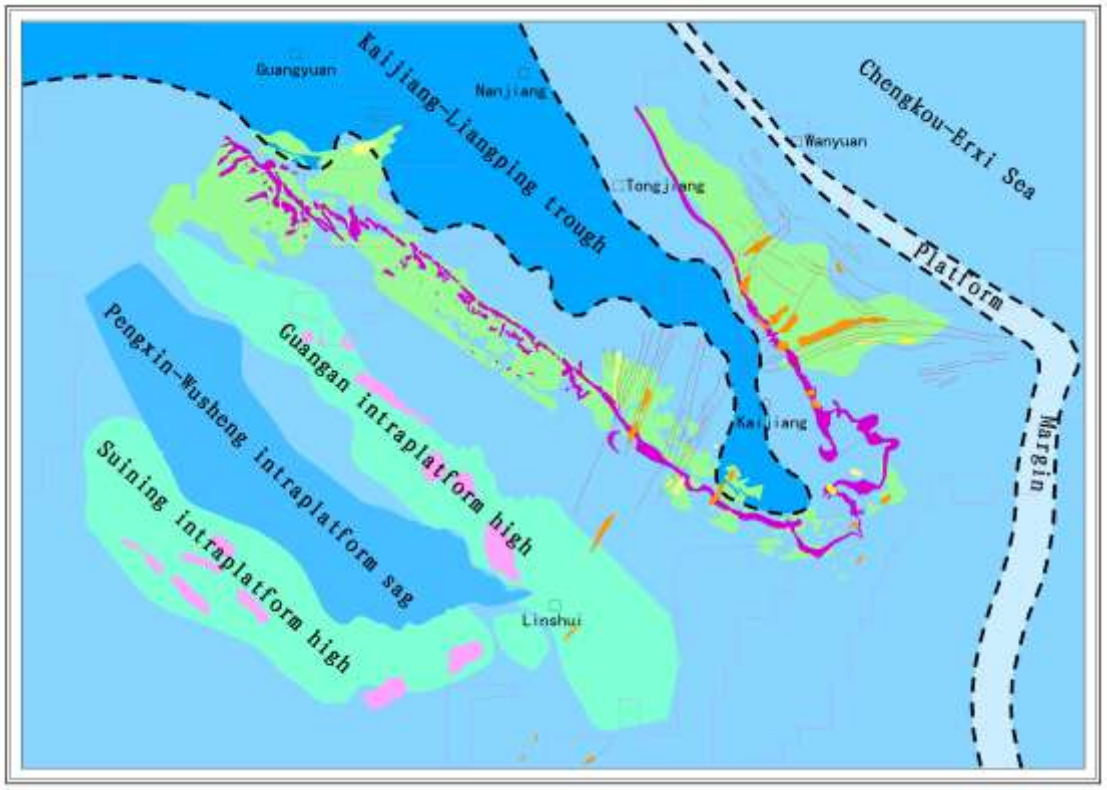
The West-East gas pipeline's main source of gas

- Potential area: 28000km^2
- Discovery: Kela-2 with a daily output of 0.7 mcm in 1998
- Proven gas in place by 2010: 0.5tcm
- Resources: 3.2tcm
- Types: foreland thrust belts
- Characteristics: high pressure and high abundance

(1) Significant progresses

③ Reef-bank gas field of Sichuan basin

Marine carbonate reservoir is playing more important role

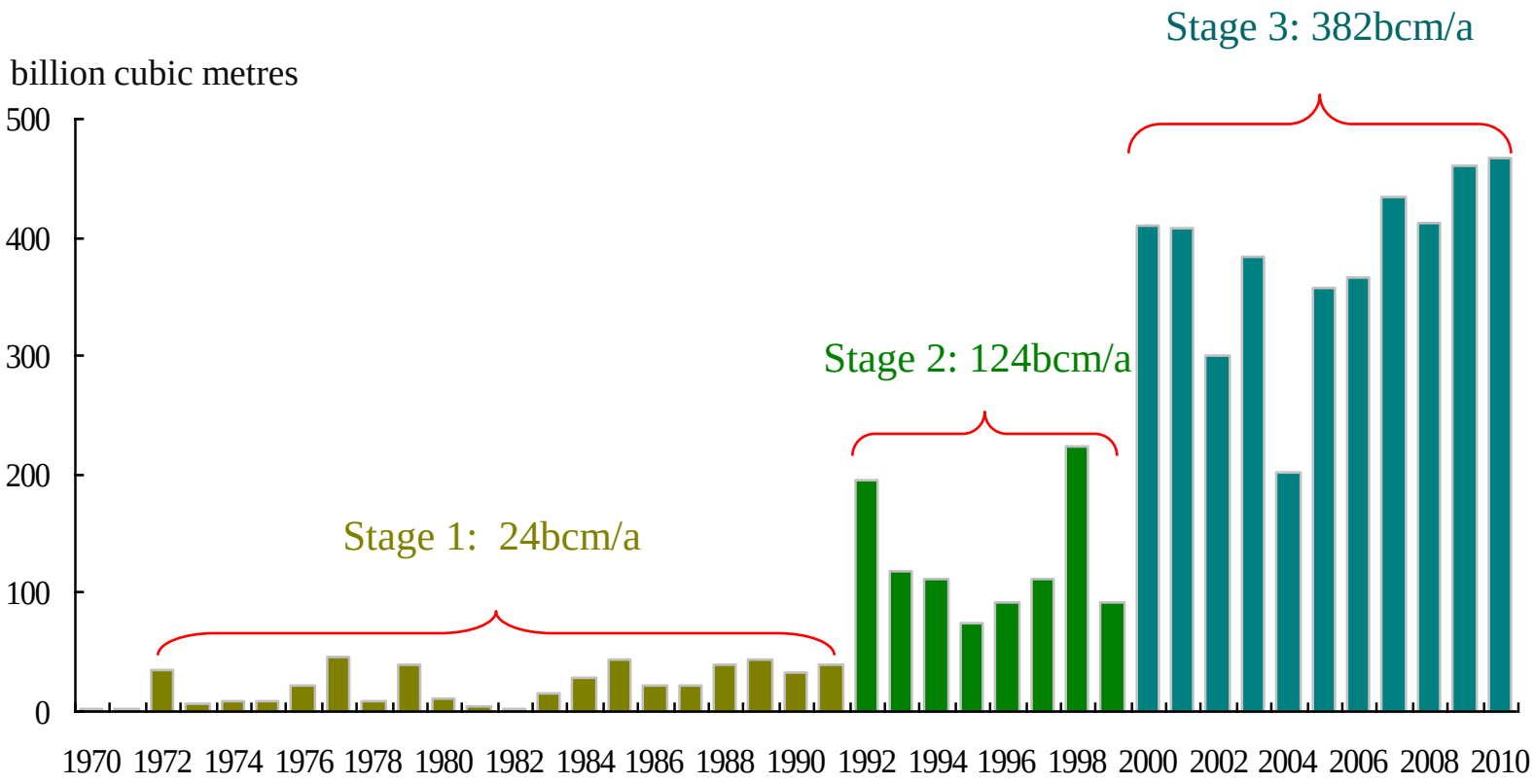


Distribution map of Reef-bank reservoirof Changxing, Feixianguan formation

- Potential area: 36000km^2
- Proven gas in place by 2010: 0.2tcm
- Resources: 2.2tcm
- Types: Organic reef-bank reservoirs
- Characteristics: high sulphur-bearing

(2) Entering rapid development period

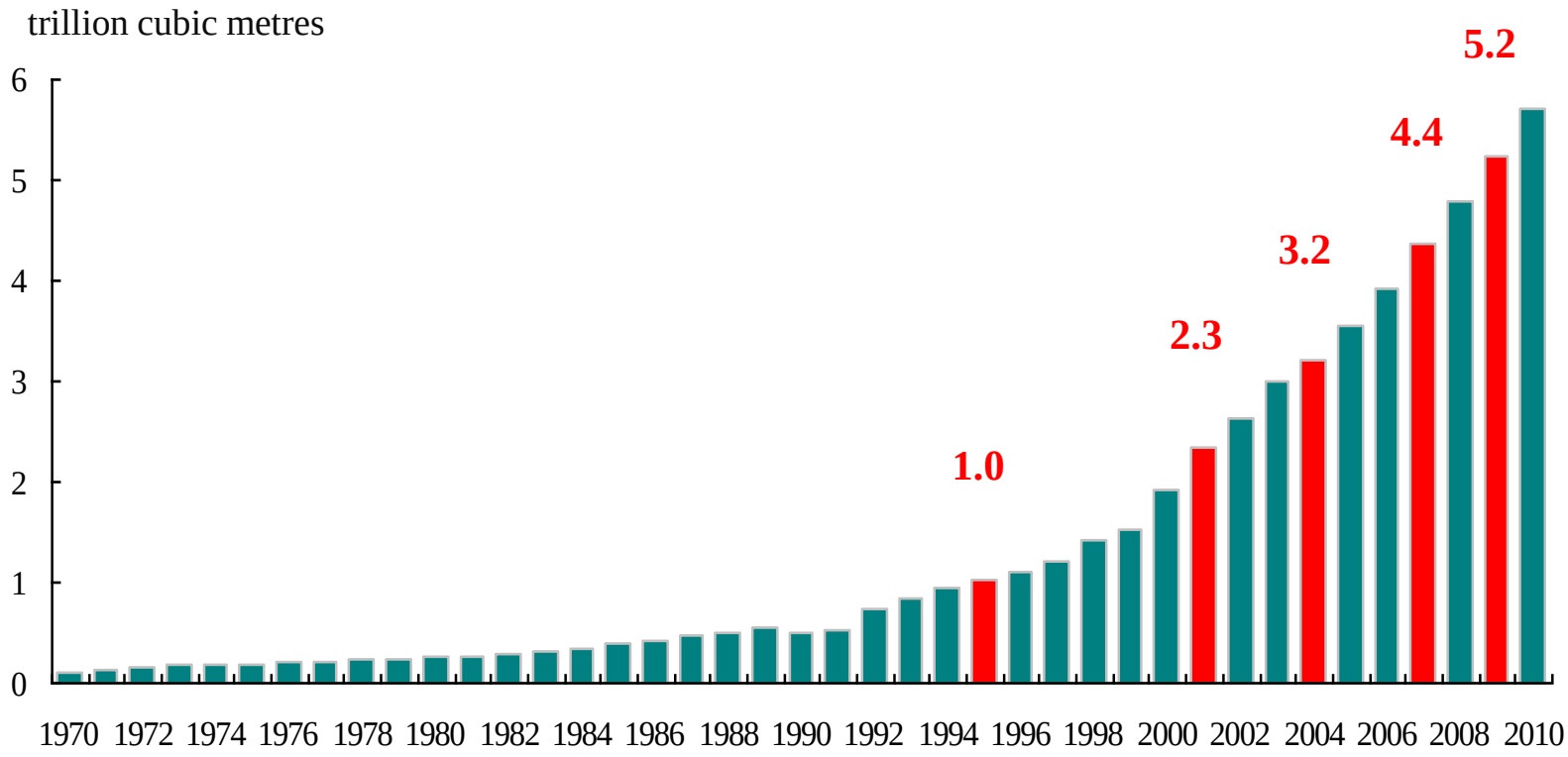
- The period for the fastest increase of the natural gas geological reserves along the history of CNPC



Time Diagram of Natural Gas Reserves Increase of CNPC

(2) Entering rapid development period

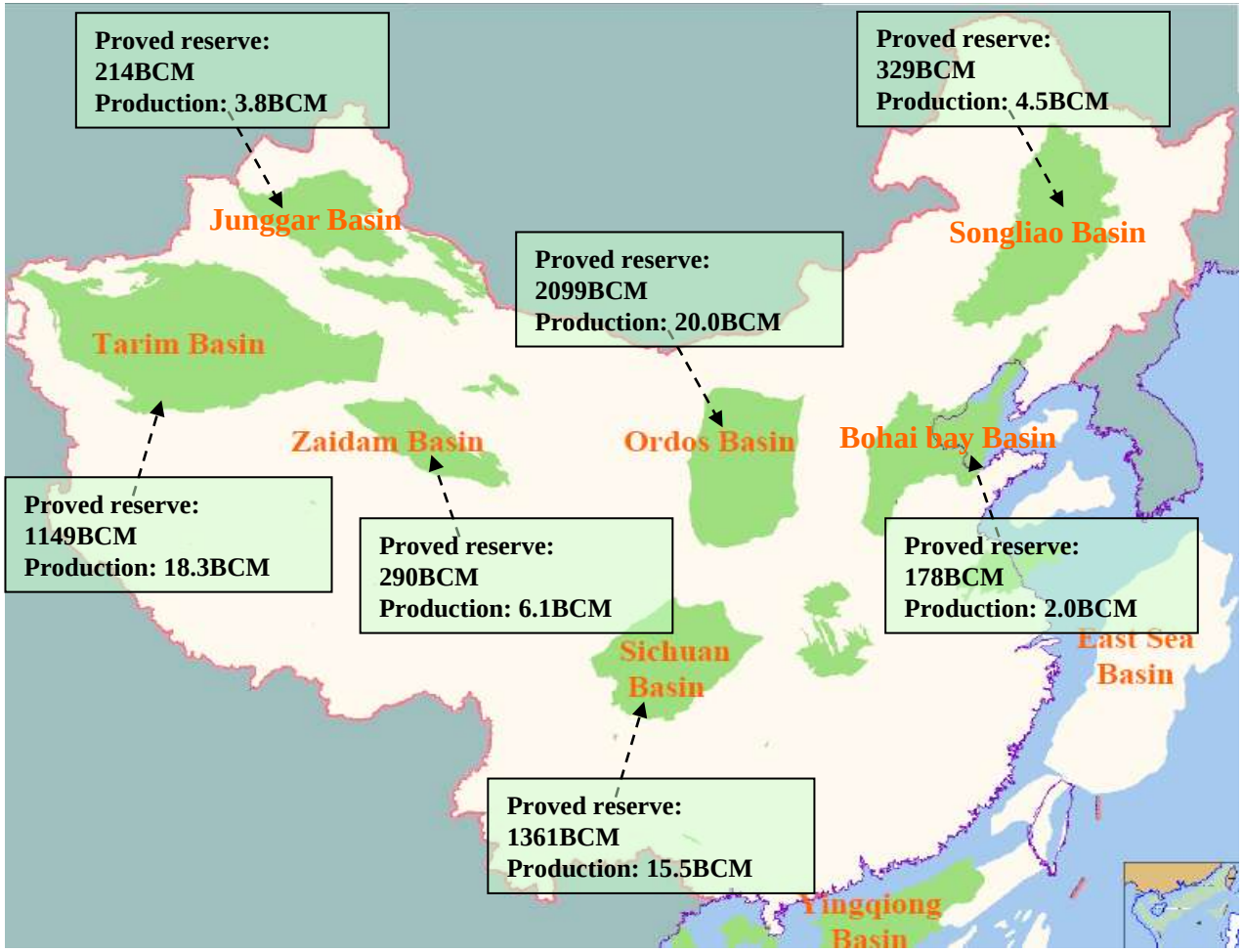
- The five leap-jumping milestones



Accumulative proved natural gas reserves by year of CNPC

(3) Seven Giant gas provinces onshore

- Accounting for 98% proven reserve and 97% production of CNPC



Note: Reserve until to the end of 2010; Production in 2010

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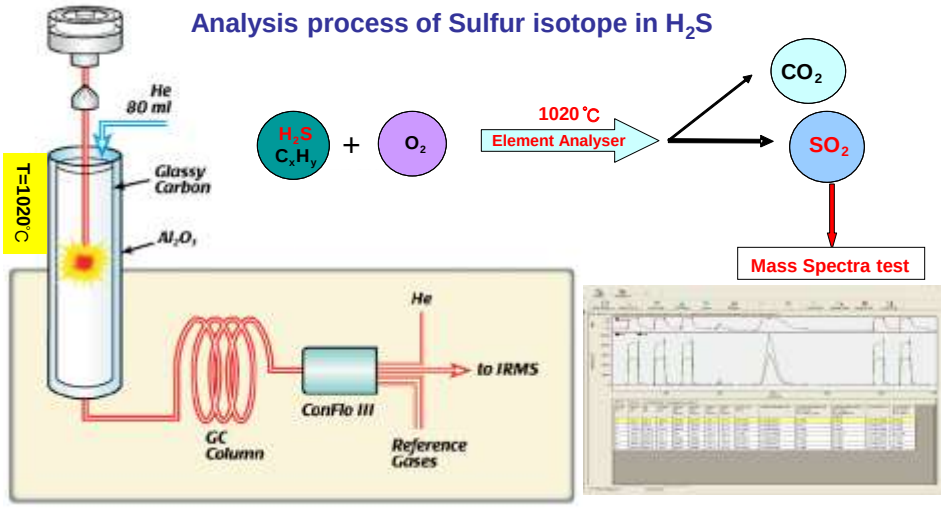
Advances prompt the exploration success

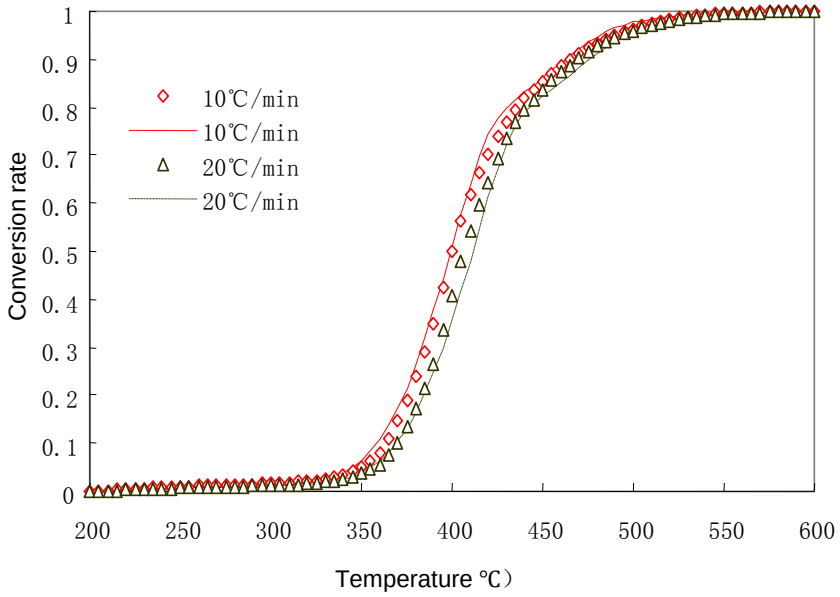
- ✓ New knowledge of natural gas geological theory

  - The theory of hydrocarbon generation from coal
  - Mechanism of rapid burial, deep fluid corrosion, reservoir overpressure and structural fracture
  - The sealing mechanism of giant gas field

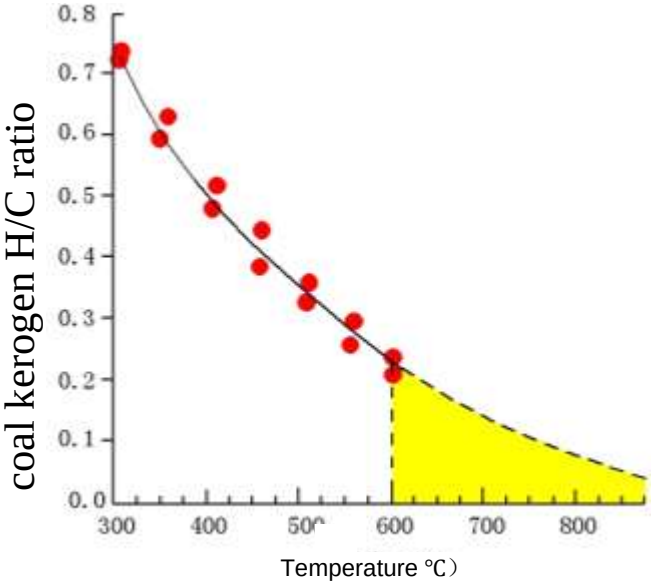


(1) Still another 20% potential in over-mature stage

- The past: the maximum analog temperature for hydrocarbon generation is 600℃ (Ro approximately 2.5%) and the gas generation capacity is depleted at such temperature;
- At present: from the evolutionary trend of coal kerogen and atomic ratio H/C that gas generation process of coal does not end and shall have great gas generation potential.



Stimulated Gas Production Rate Curve

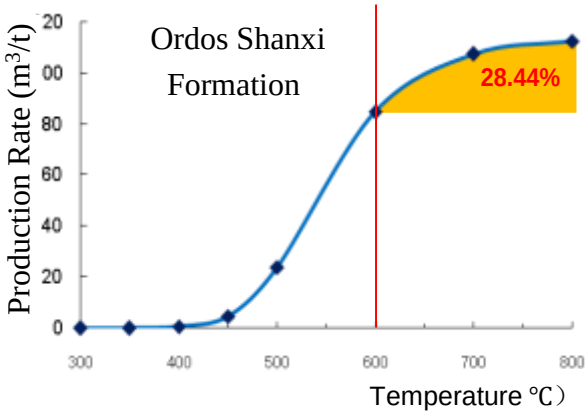


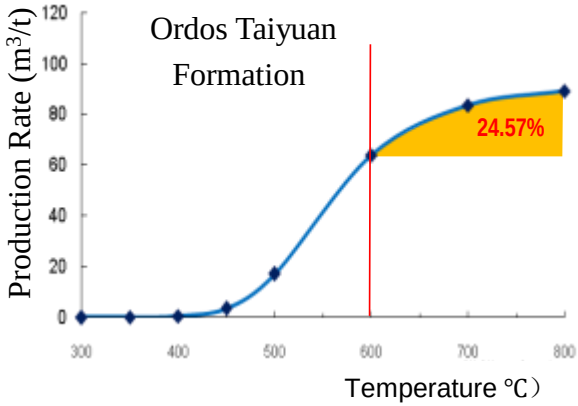
evolutionary trend of coal kerogen and atomic ratio H/C

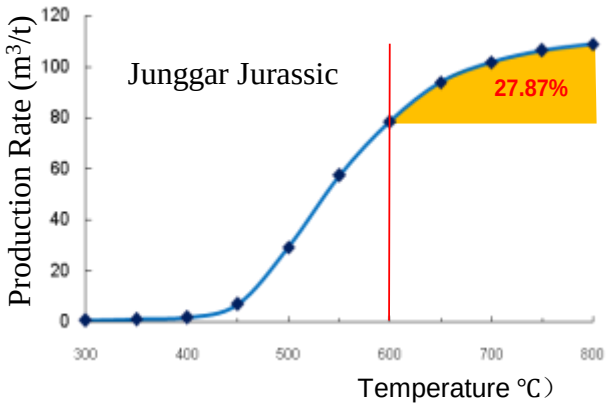
(1) Still another 20% potential in over-mature stage

- High temperature, high pressure experiments

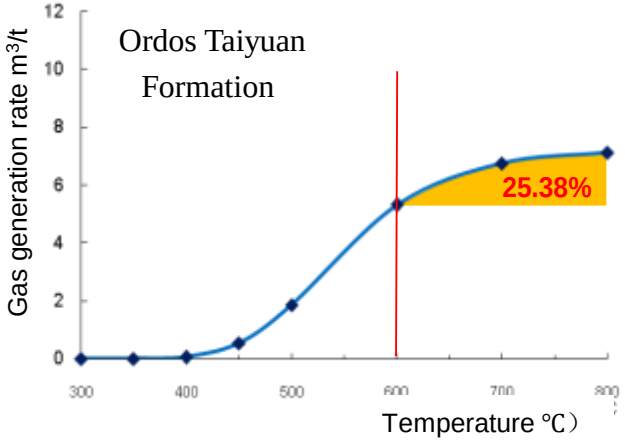
Coal:

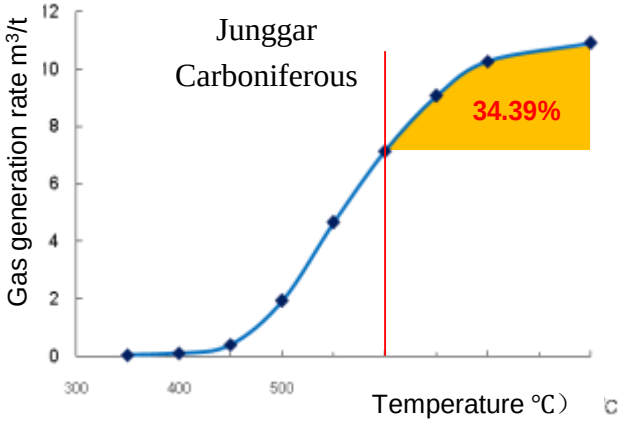






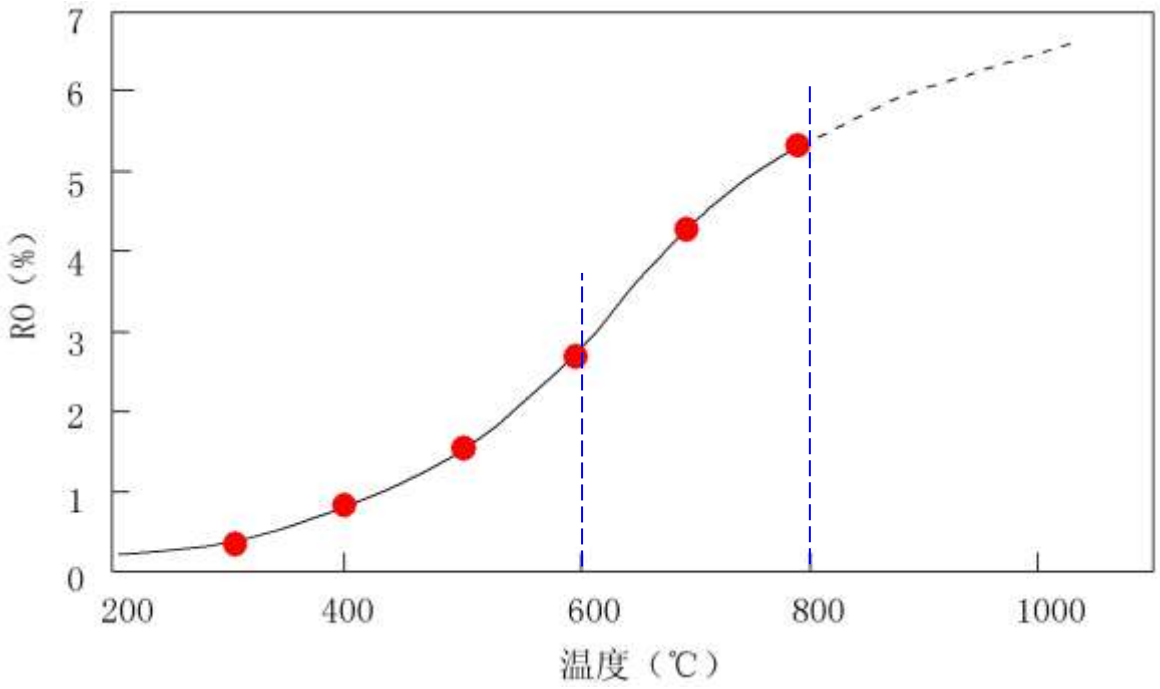
Carbonaceous:





(1) Still another 20% potential in over-mature stage

- Vitrinite reflectance corresponding to Ro=2.5%～5.0%, still can generate over 20% of natural gas in total gas generation.



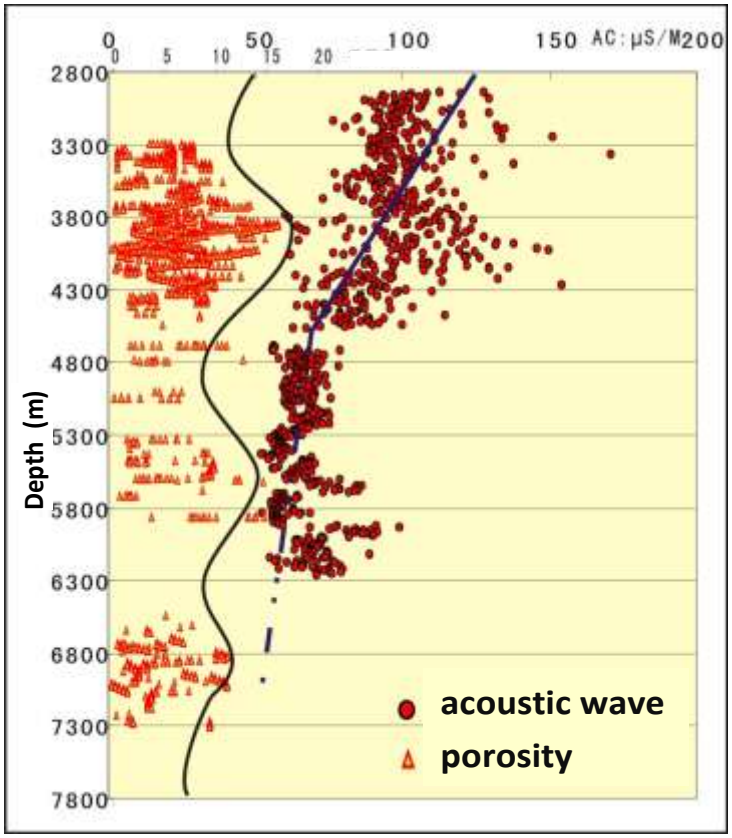
Relation Diagram between Thermal Stimulated Temperature and Ro

(2) Forming mechanism of deep pore

- The newest research broke through the lower limit deep of clastic reservoir:
  - ✓ Rapid burial, relatively weak diagenesis, and a part of primary pores are preserved
  - ✓ In deep fluid solution, acidic fluid high temperature often dissolve particles to form secondary pores
  - ✓ Reservoir overpressure is helpful for retaining original pores
  - ✓ In structural fracture, multiphase tectonic often cause mesh pores

(2) Forming mechanism of deep pore

- The depth of exploration in central and western basin increased 1000~2500m



The relationship between Cretaceous porosity and acoustic wave in Kuqa region

- ✓Rapid burial, reservoir overpressure and structural fracture increased 1000~2500m of the exploration depth in central and western basin, which directly led to the discoveries of Tarim, Tuha, Sichuan Basin

Deep clastic rocks in central and western China

Exploration domain	Past depth (m)	Now depth (m)	Reservoir types
Kuche(K)	5500~6000	8000	overpressure-fracture
Tuha(J)	3500	4500	overpressure-fracture
Sichuan Southwest	4000	5000	fracture-solution

(2) Forming mechanism of deep pore

- The depth of exploration in east basin increased 1000~1500m

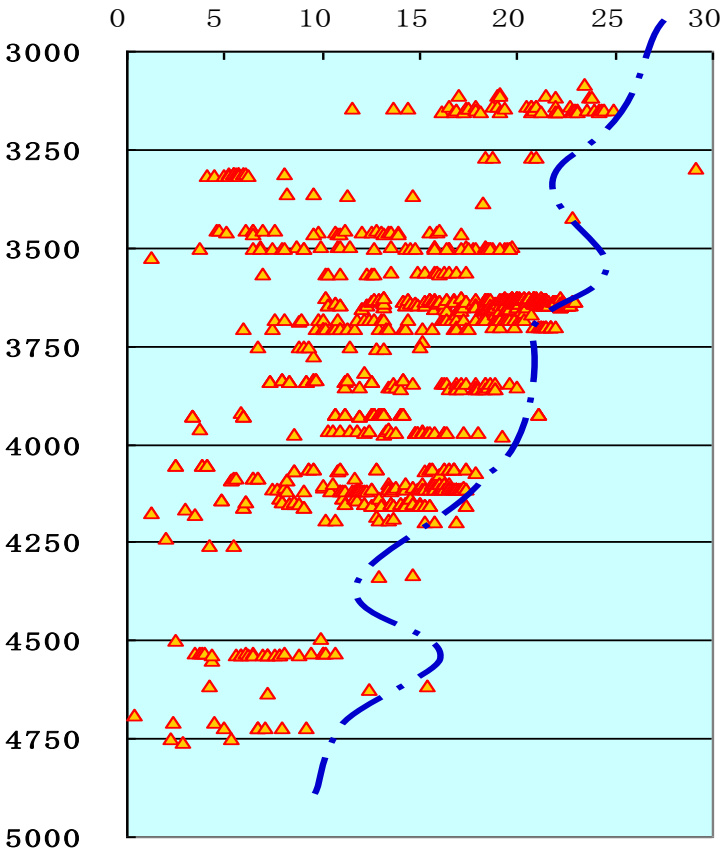


Fig. 4 The relationship between Cretaceous porosity and acoustic wave in Qikou Binhai region

✓High geotemperature gradients and multiphase fluid corrosion increased 1000~1500m of the exploration depth in east basin, which directly lead to the discoveries of Bohai bay and Songliao Basin

Deep clastic rocks in east basins in China

Exploration domain	Past depth (m)	Now depth (m)	Reservoir types
Deep layer, Songliao	4000m	5000m	Dissolved pore
Qikou Binhai region	3500-4000m	5000m	Fractured Corrosion

(3) Controlling factors on China's giant gas field

- large-scale litho-stratigraphic accumulation rate can reach 3~5%

C-P accumulation rate in Ordos basin

Block	Area (km^2)	Resource (BCM)	Accumulation rate (%)
West Sulige (Ⅰ)	8513	596.9	3.0
Middle Sulige	6361	533.7	3.2
East Sulige (Ⅰ)	6622	611.5	4.3
Yulin	3241	209.4	3.0

T_3 accumulation rate in Sichuan basin

Block	Area (km^2)	Total gas generation (BCM)	Reserve (BCM)	Accumulation rate (%)
Guangan	1733	2947.0	135.6	4.6
Bajiaochang	208.8	730.8	35.1	4.8
Hechuan	1515	1515.0	118.7	5.2

Fig. 4 The relationship between T_3 gas generation and gas field distribution in Sichuan basin

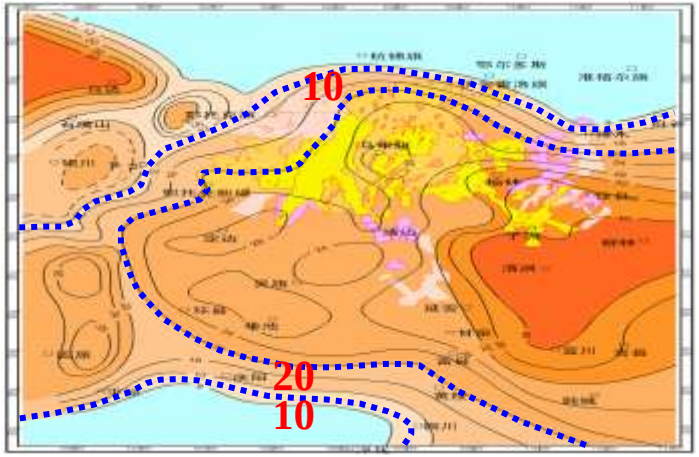


Fig. 4 The relationship between C-P gas generation and gas field distribution in Ordos basin

(3) Controlling factors on China's giant gas field

- Regional caprock strictly controlling the distribution of giant gas field

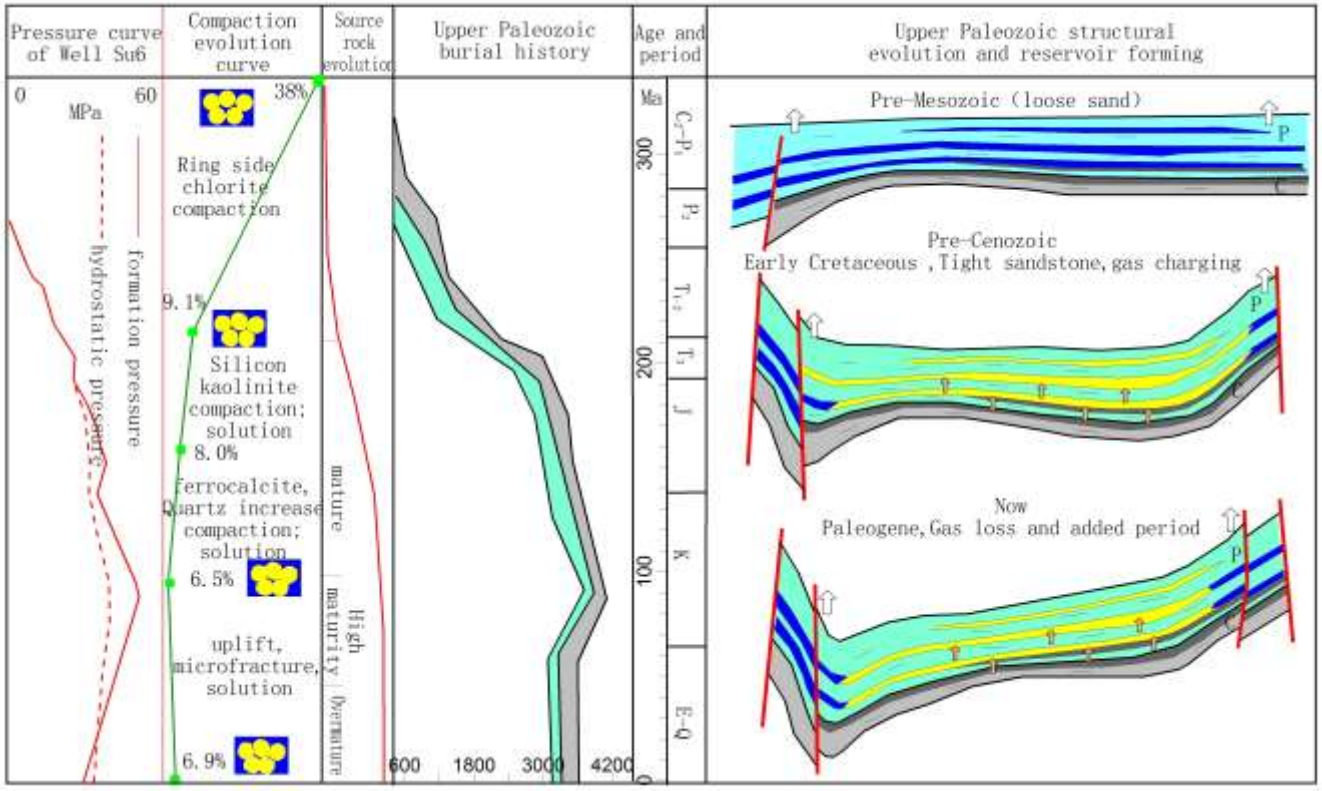


Fig.6 Distribution of regional caprocks and natural gas in large gas fields in China

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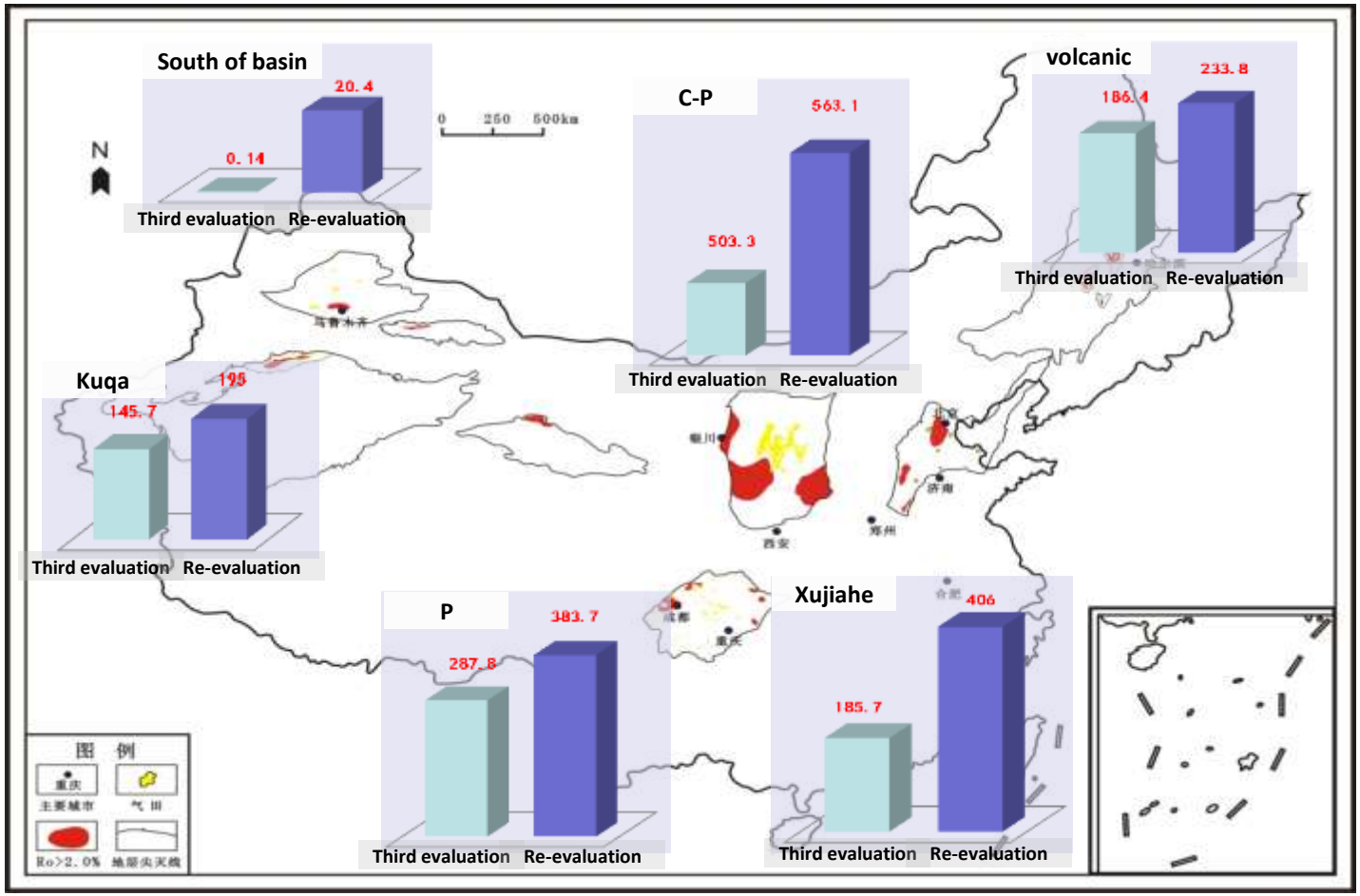
(1) Resources increased by 70%

- Total gas generation increased by 38%



Total gas generation re-evaluation comparation to the third resource evaluation(TCM) Fig.

(1) Resources increased by 70%

- Upper Permian-Lower Triassic reef gas reservoir field in Sichuan basin

Upper Permian-Lower Triassic re-evaluation in Sichuan basin Table

Block	Chuandong	Chuanzhong	Chuannan	Chuanxinan	Chuanxi	Chuanbei
Total gas generation (TCM)	107.81	124.92	51.26	62.84	37.04	79.70
gas generation intensity (BCM/km^2)	2.33	3.05	1.92	1.86	1.73	2.71
Accumulation rate (%)	1.04	0.47	0.21	0.16	0.21	1.13
Resource (TCM)	1.12	0.59	0.11	0.10	0.08	0.90

(1) Resources increased by 70%

- Upper Paleozoic large-scale litho-stratigraphic in Ordos basin

Upper Paleozoic large-scale litho-stratigraphic re-evaluation in Ordos basin Table

Evaluation Method	Conversion Rate (%)	Resources(TCM)		
		95%	50%	5%
Geology Analogy	0.45	9.21	13.08	16.92
Basin Simulation	0.35	9.41	13.17	17.12
Saturation well	0.1	7.87	11.24	14.57
Delphi	/	9.22	12.20	16.91

(1) Resources increased by 70%

- Deep structure in Kuche depression

Deep structure re-evaluation of Kuqa depression in Tarim basin Table

Evaluation Method	Conversion Rate (%)	Resources(TCM)		
		95%	50%	5%
scope sequence	0.40	2.91	4.16	5.40
Basin Simulation	0.40	3.20	4.57	5.94
Geology Analogy	0.20	3.09	4.42	5.74
Delphi	/	3.06	4.38	5.68

(1) Resources increased by 70%

- Four key basins resources increased 12tcm, 70% more than third evaluation

Comparison of the resource evaluation results in major natural gas exploration fields of CNPC Table

Basins	Exploration domains	The third evaluation（tcm）	Re-evluation（tcm）	Increase（tcm）
Sichuan	Upper Permian - Lower Triassic reef	2.1	2.9	0.8
	lithologic in Xujiahe	0.9	5.6	4.7
Songliao	Volcanic	2.0	3.9	1.9
Ordos	Upper Paleozoic large area lithologic	8.8	12.2	3.4
Tarim	Deep structure in Kuqa depression	3.2	4.4	1.2
Total		17.0	29.0	12.0

(2) Optimizing ten potential targets

- Ten potential targets 10.2 tcm resource which will establish a foundation

Re-evaluation results of exploration targets in CNPC Table

Domains	No.	Basins	Favorable zones	Area (10 thousand km^2)	Resources (tcm)
large-scale litho-stratigraphic	1	Ordos	East of Sulige	2.50	2.50
	2	Ordos	Gaoqiao	0.62	1.00
	3	Sichuan	Guangan - Yingshan	1.10	0.30
carbonate	4	Sichuan	Longgang Platform Margin	2.50	0.5-1
	5	Tarim	Tazhong North Slope	0.20	0.80
	6	Ordos	Weathering crust around Jingbian	1.20	0.75
Volcanic	7	Songliao	Xujiaweizi Fault	0.54	0.68
	8	Songliao	Changling Fault	0.70	1.10
Foreland thrust	9	Tarim	Kuqa	2.80	2.00
	10	Tarim	Taxinan thrust belt	2.00	1.10
Total				14.16	10.23

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(1) Natural gas resources being growing

- Natural gas resources increased 10tcm every ten years. With the unconventional gas resources, such as shale gas etc. tapping

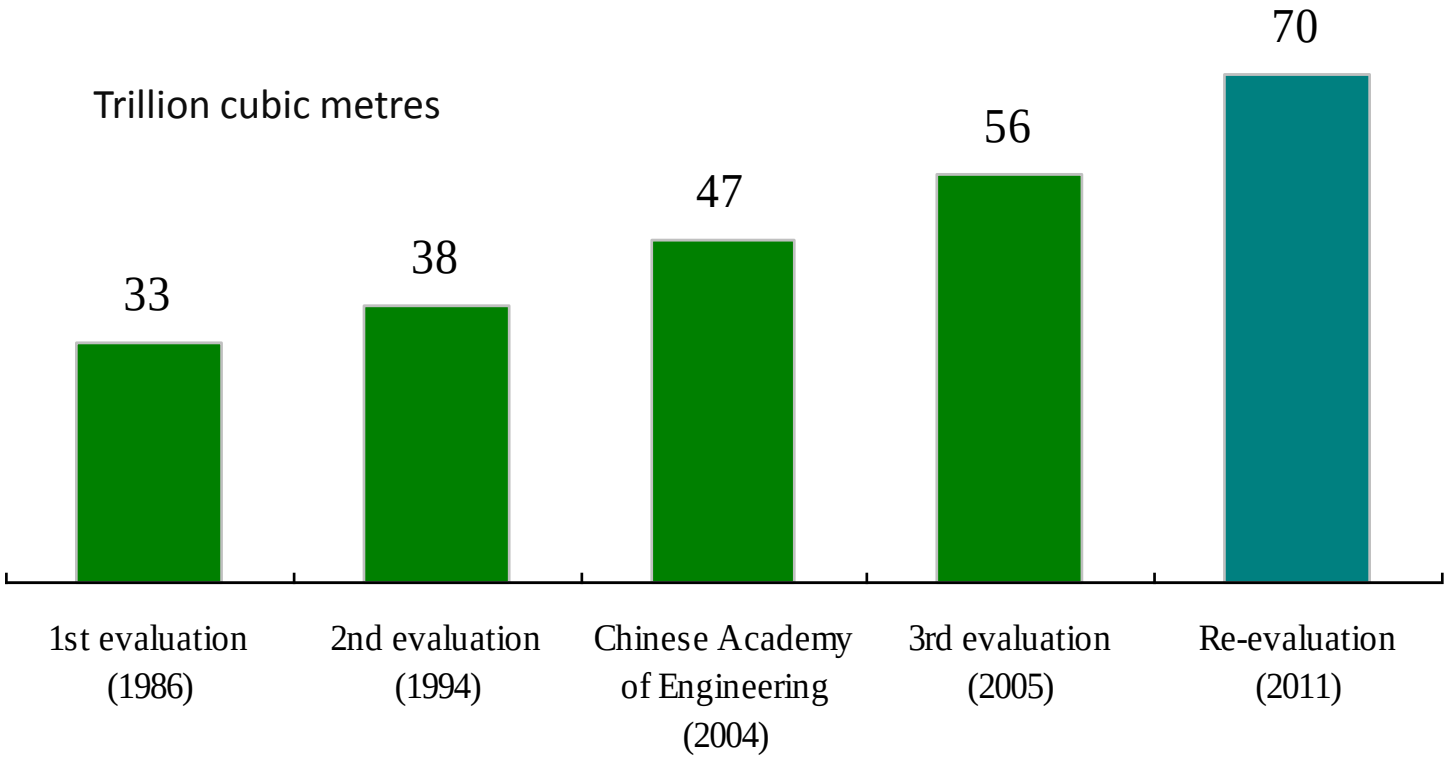
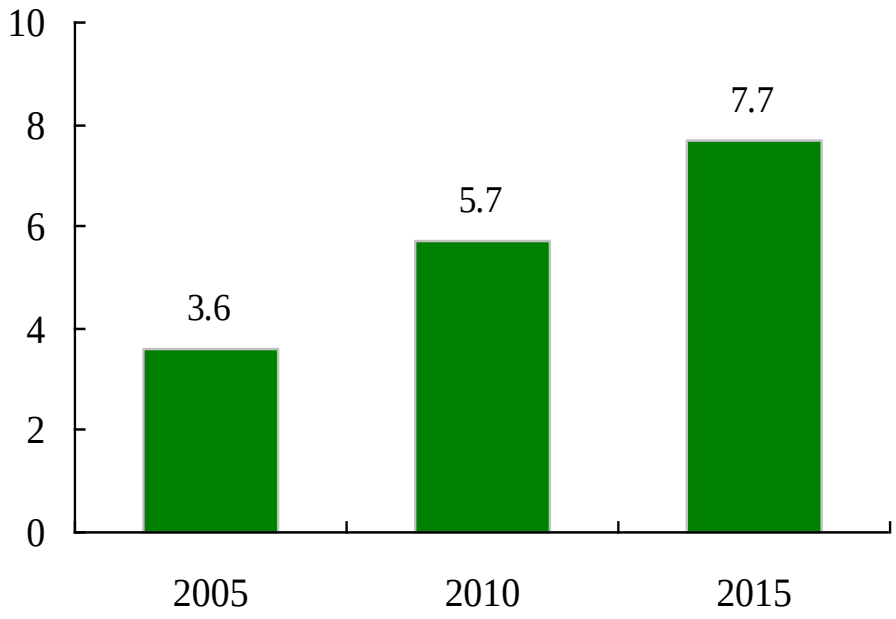


Fig.1 Evaluation history of natural gas resources in China

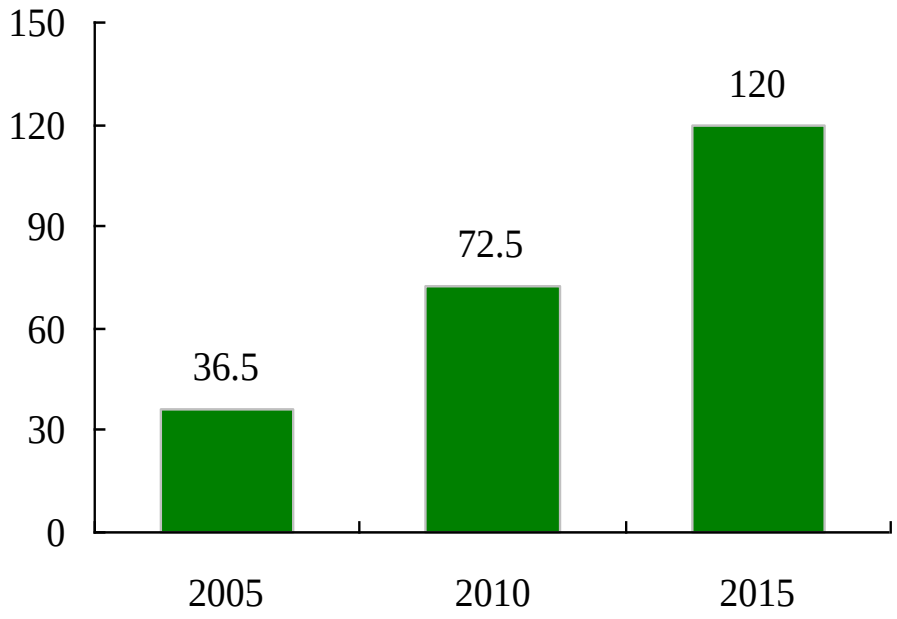
(2) Natural gas industry in the fast track

- CNPC's domestic accumulative proven reserves and production are projected to reach 7.7tcm and 120bcm respectively by 2015

Steady Increase of CNPC's Domestic Natural Gas Proven Reserves (trillion cubic meters)



Steady Increase of CNPC's Domestic Natural Gas Production (billion cubic meters)



(3) Big promising for natural gas in the future

- China has made many significant achievements in gas and natural gas exploration from 2006 to 2010
- Under the guidance of the new understanding on the geological theories, all natural gas resources in major gas-bearing basins in China were re-evaluated
- The comprehensive evaluation selected favorable exploration targets in the main focus exploration fields of the major gas-bearing basins in China

Acknowledgement & Contact

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Thanks for your attention!