U.S.—China
Clean Coal Forum

25-26 August, 2015 · Billings MT U.S.

Coalbed Methane Development status of CNPC and China

中国煤层气开发现状及中国石油的研发与生产

CNPC

August 2015

Content

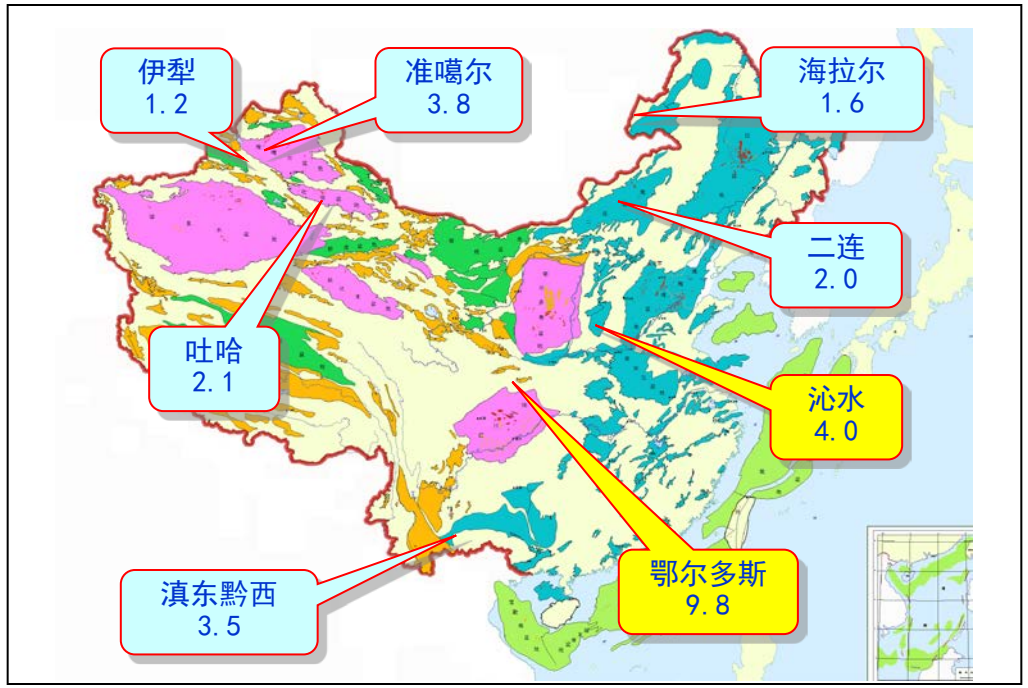
Part 1 CBM Overview in China

中国煤层气产业概况

I. Resource 资源基础

- **< 2,000 meters: 36.81 trillion m3**
- **8 basins (>1 TCM for each): 2.8 TCM, accounting for 76% of China, mainly distributed in the middle and west of China.**

- 资源分布相对集中
- 2000米以浅资源量36.81万亿方
- 8个资源量大于1万亿方的盆地合计28万亿方，占全国76%，主要分布于中西部地区



China's CBM resources distribution

中国煤层气资源分布图（据国土资源部, 2005）

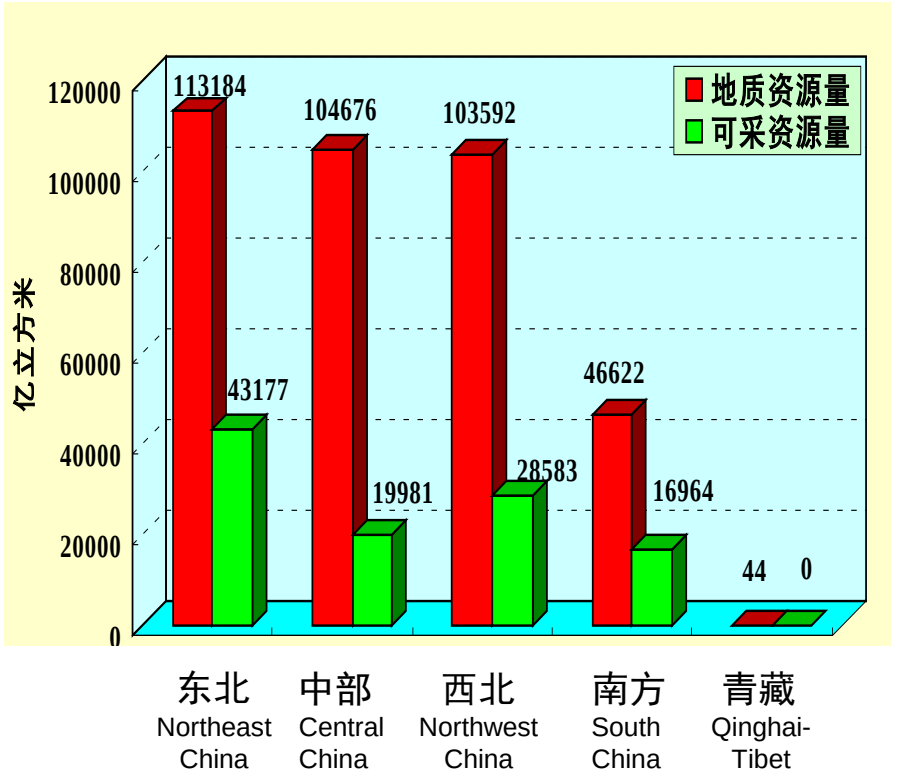
CBM distribution properties

- **Northeast and Northwest: low gas content and small scale**
- **Southern China: limited scale and dispersed**
- **Northern China:stably distributed with high content**

- 东北和西北地区含气量偏低，规模小
- 南方地区分布局限，资源分散
- 华北地区，煤层分布稳定，含气量高

China's CBM resources distribution histogram (10^8 m^3)

中国煤层气资源地区分布直方图（亿方）

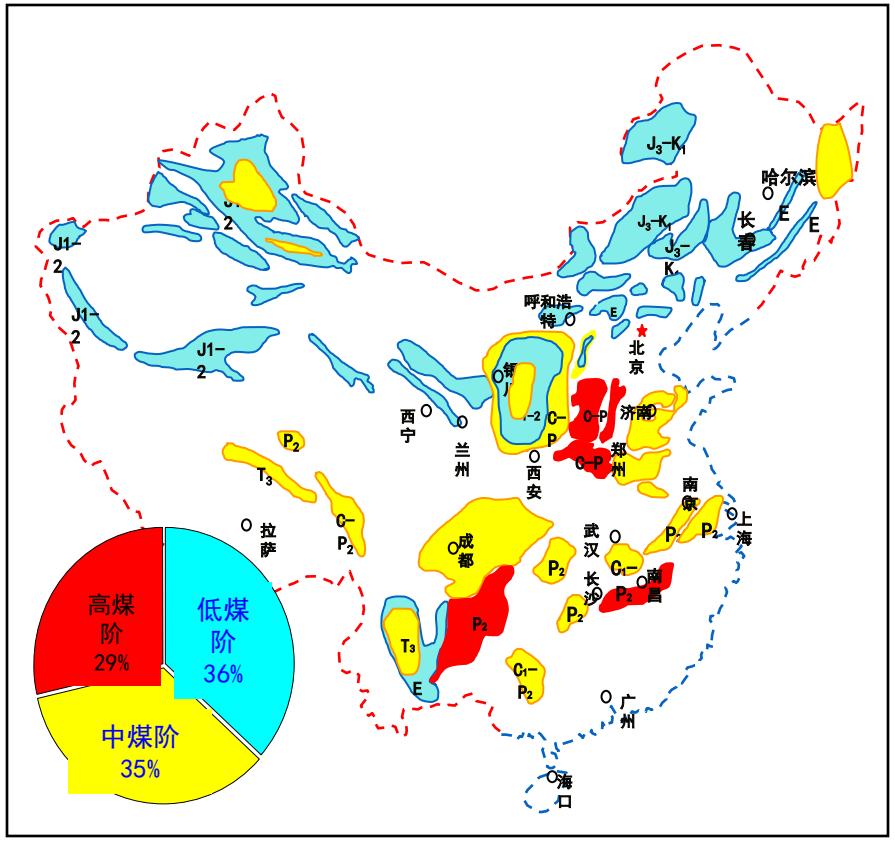


The high, medium and low rank accounts for one third respectively

- **High rank: 7.82 TCM, 29%**
- **Medium rank: 9.52TCM, 35%**
- **Low rank: 9.98 TCM, 36%**

高中低煤阶各占三分之一：

- 高煤阶：7.82万亿m^3，29%
- 中煤阶：9.52万亿m^3，35%
- 低煤阶：9.98万亿m^3，36%



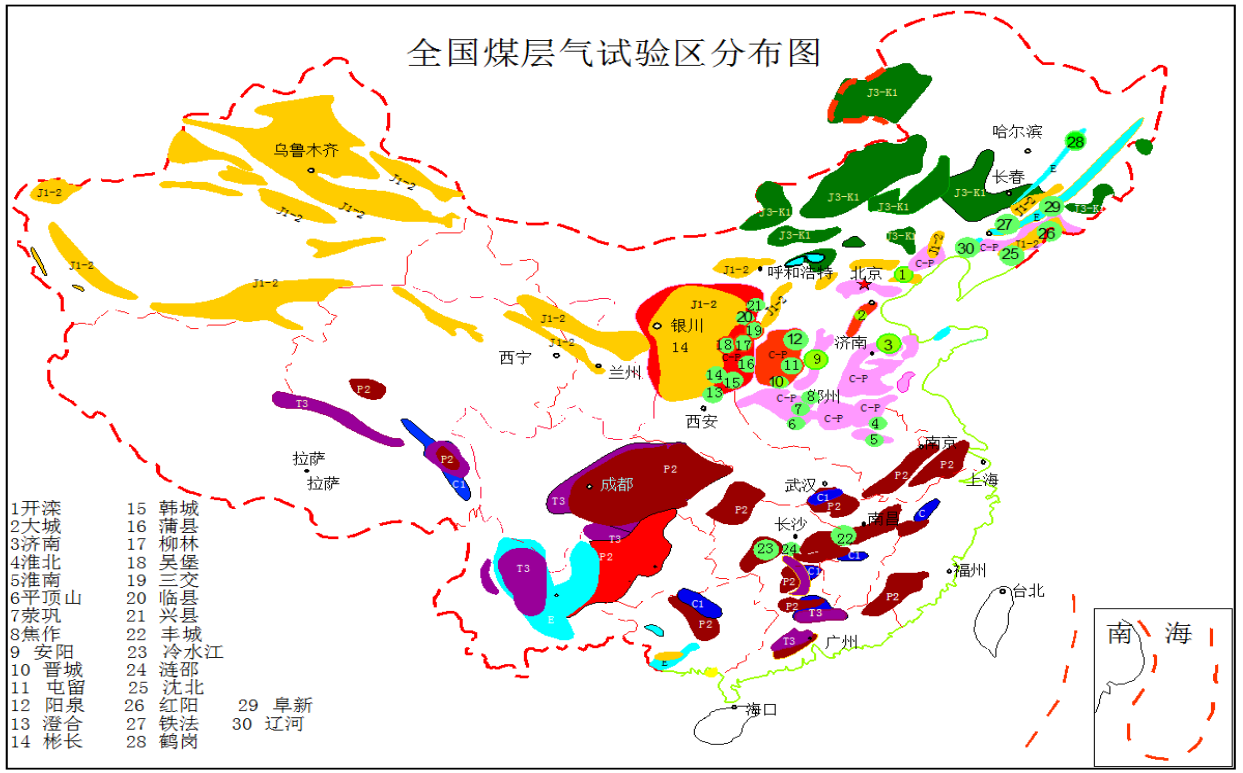
Distribution of high, medium and low rank CBM resources

我国高、中、低煤阶煤层气资源分布简图

II. History 发展历程

- **since 1980‘s，more than 30 targets evaluated**

自1980’s年代起， 中国逐步在30多个煤层气目标区开展了前期评价

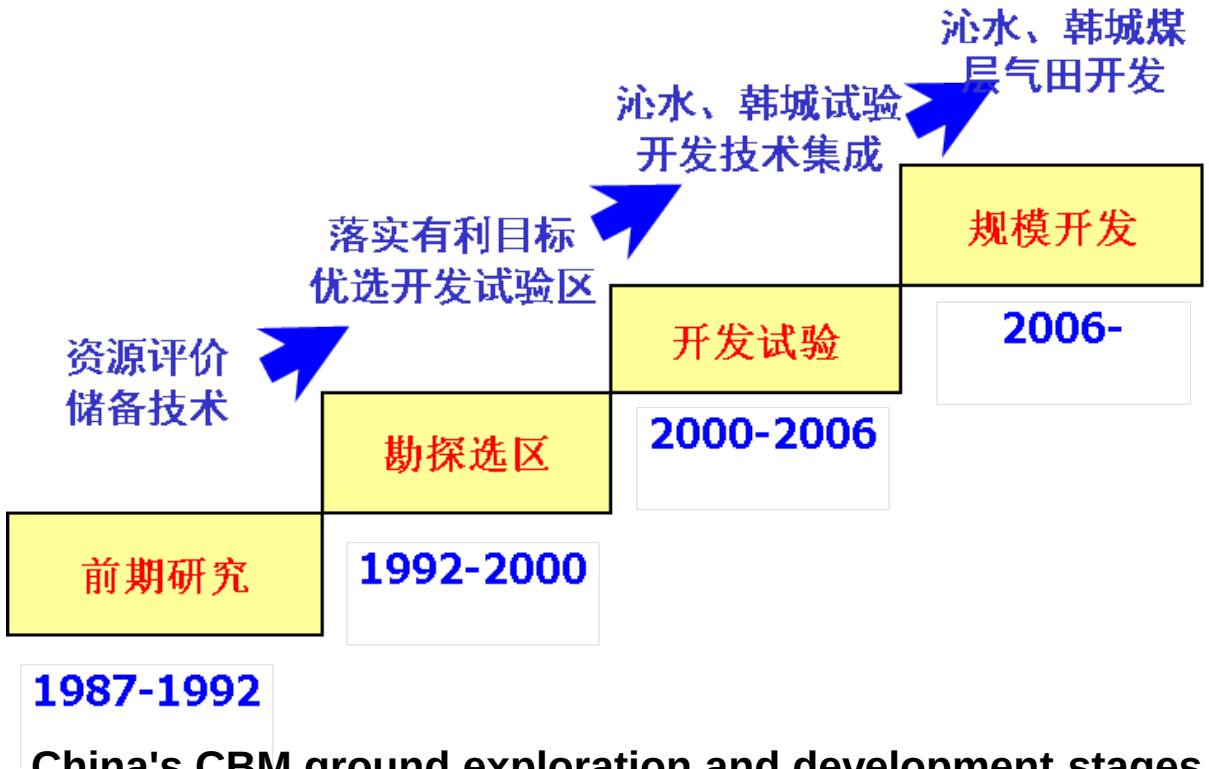


China's main CBM ground exploration and development blocks

中国主要煤层气地面勘探开发区块

- **1989：CNPC kicked off R&D project**
- **1996：CUCBM carried out CBM survey**
- **2006：CNPC， JAMG stepped into CBM commercialized development**

1989年，中石油开始煤层气研究；1996年成立中联煤层气公司，开展煤层气资源勘查；2006年，晋煤进入地面开采；2006年，中国石油开展煤层气开发建设



China's CBM ground exploration and development stages

中国煤层气地面勘探开发阶段

- **20+ enterprises**
- **10 colleges and universities**
- **8 professional institutes & agencies**

- 20多家国内外企业在从事煤层气勘探开发
- 近10所高校，8家专业机构从事理论和技术研究

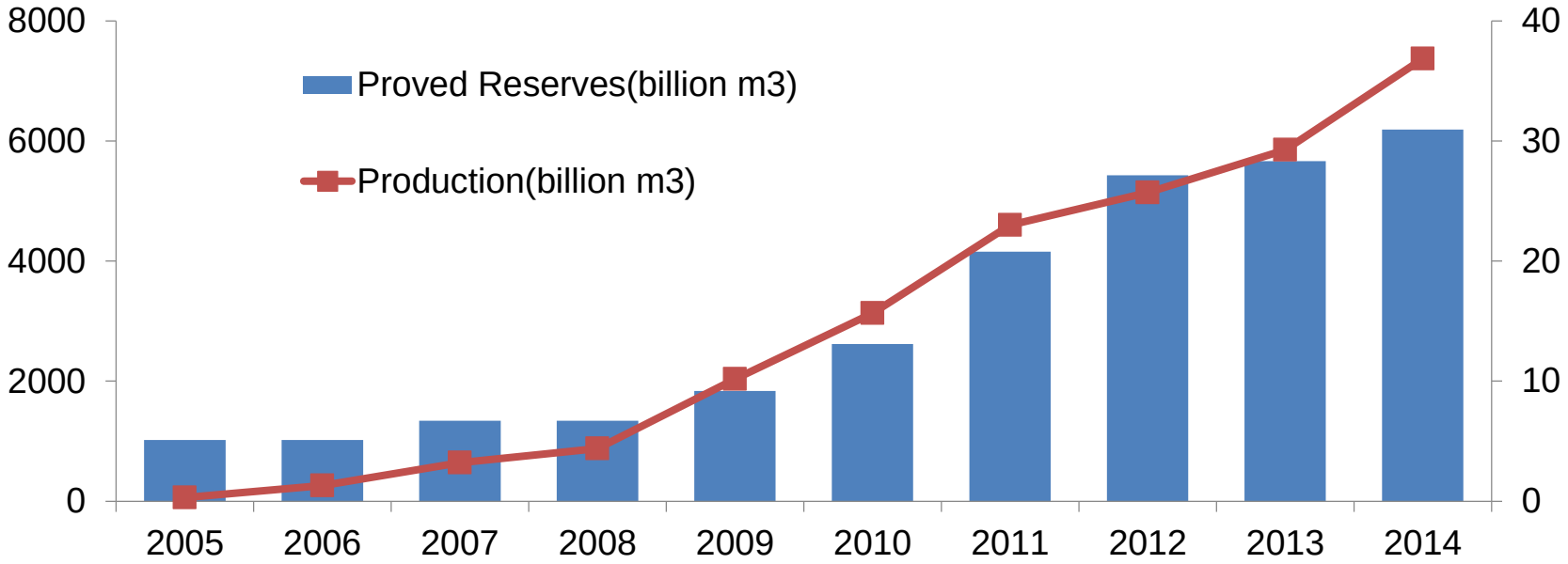
III. Policy support 政策扶持

Price preference 价格优惠	**The CBM price based on the market** 价格按市场经济原则，由供需双方协商确定，国家不限价（国办通〔1997〕8号）
Tax preference 税收优惠	**Import duties and VAT shall be exempted for the equipment of CBM** **"refund after collection" of the VAT** 与煤层气有关的设备免征进口关税和增值税（财关税〔2006〕13号） 实行增值税先征后退政策（财税〔2007〕16号）
Development subsidies 开发补贴	**0.2 RMB/m^3 (pure volume) subsidies for CBM** 中央财政按0.2元/方煤层气（折纯）标准进行补贴（财建[2007]114号）
Power subsidies 发电补贴	**0.65 RMB/m^3 subsidies for CBM power generation** 煤层气发电补助0.65元/方（发改能源［2007］721号）
Royalty 资源管理	**Deduction and exemption of exploration right and mining right fees before 2020；Resource tax free currently** 2020年前减免探矿权使用费和采矿权使用费，暂不征收资源税（财税［2007］ 16号）

IV. Industry progress 产业进展

- **Wells: 15,000**
- **Proved Reserves：626.6 BCM**
- **Production in 2014：3.7 BCM**
- **Cumulative Production by 2014:15BCM**

截止2014年底，全国累计探明储量6266亿方，2014年产量37亿方，累计产量150亿方



China's CBM industrial progress

全国煤层气产业进展图（据国土资源部）

V. Utilization 综合利用

- **pipeline, LNG, CNG**
- **residential /industrial, vehicle, chemical, power generation**
  - 外输方式：管道、LNG、CNG
  - 用途：居民或工业燃料、汽车燃料、化工原料、发电

Auto fuel gas
汽车燃气


Purified Pipeline gas
净化管输

Resident gas
居民生活用气

Content

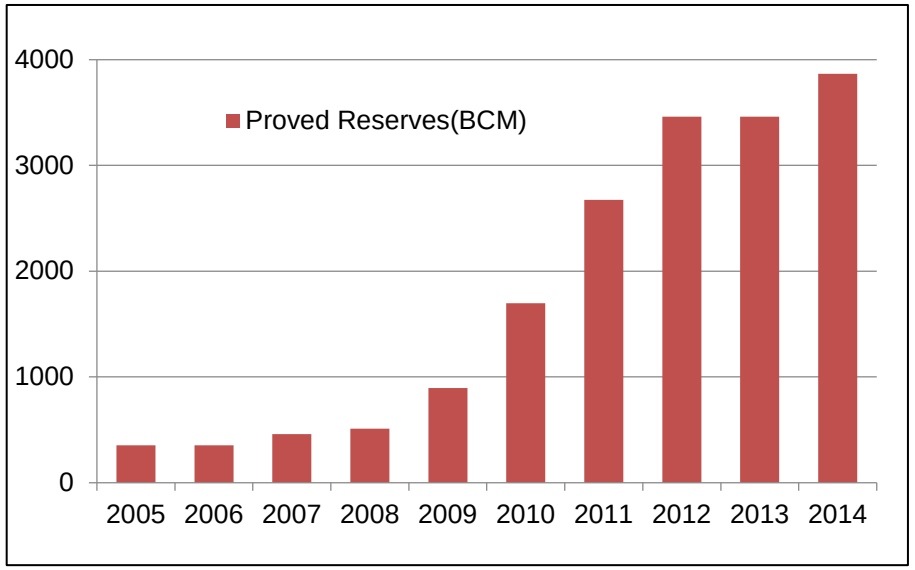
Part 2 CBM Development of CNPC

中国石油煤层气进展

I. Proved reserves and production 储产量

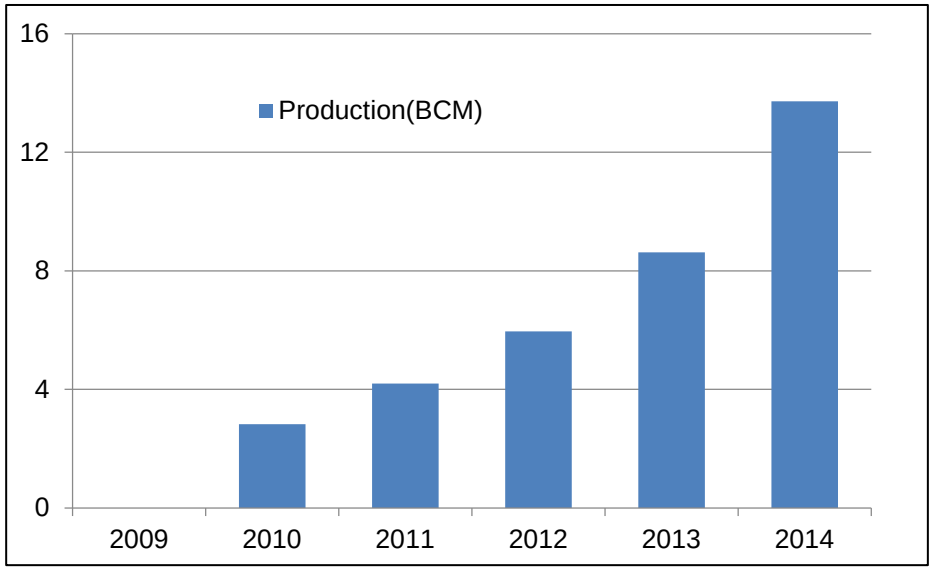
- **Proved reserves(by 2014): 386.7BCM**
- **Production(2014): 1.37 BCM**

截止2014年底，中石油累计探明3867亿方；2014年产商品气量13.7亿方



Proved CBM reserves over the years

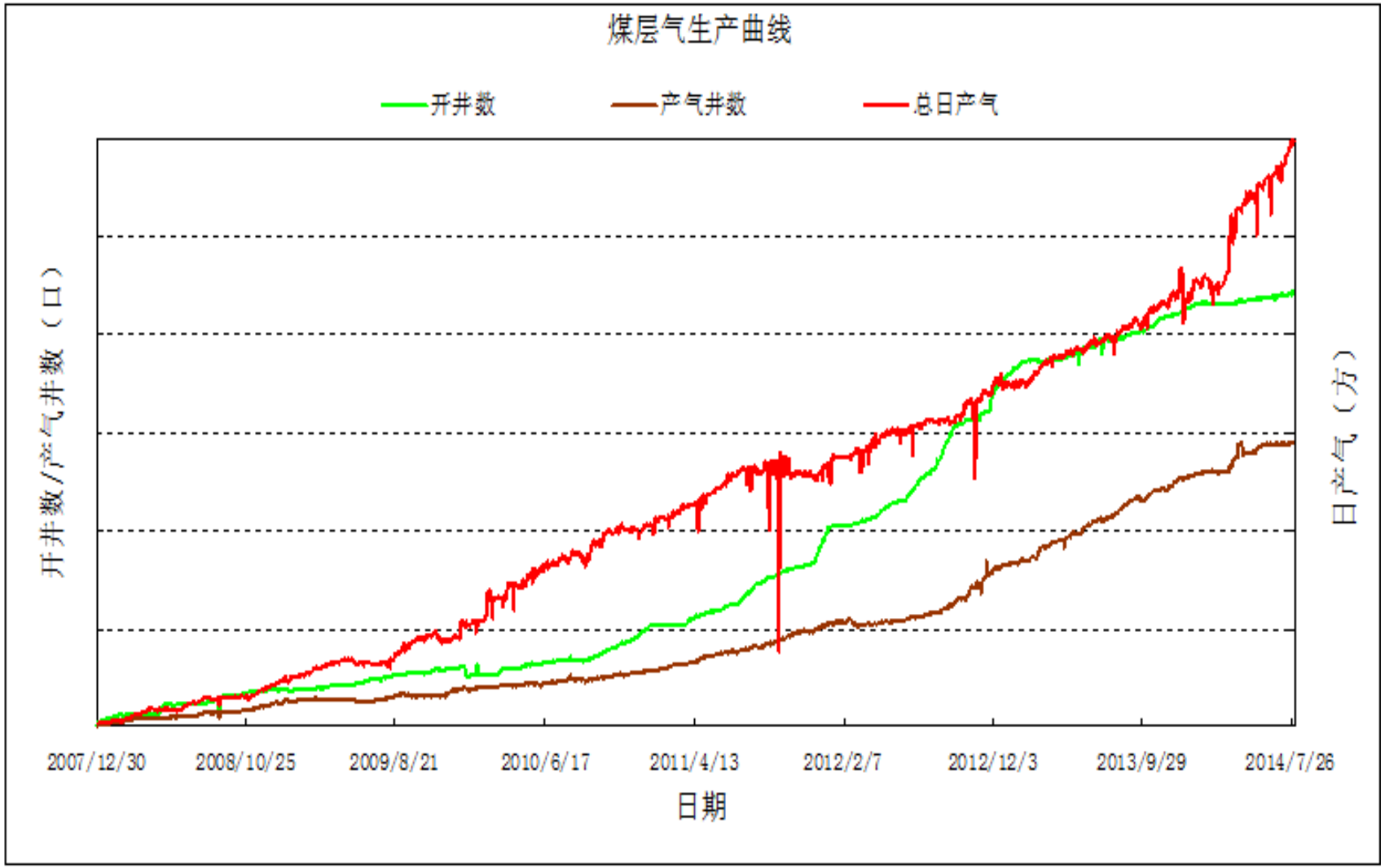
中国石油煤层气历年探明储量构成图



Proved CBM annual output over the years(MLR)

中国石油煤层气历年产量构成图

Present production：5.1 million m³ /day　　目前日产商品气510万方



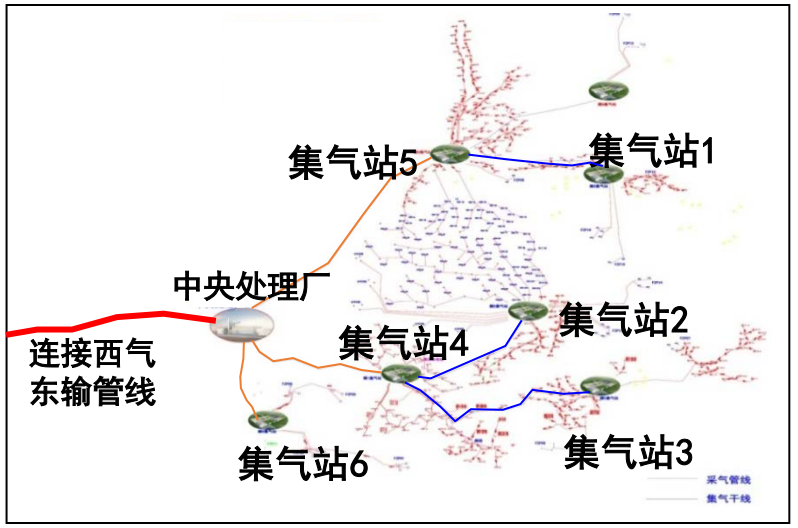
II. E&D technology series 勘探开发配套技术体系

- 3-D seismic
- cluster wells
- hydraulic fracturing
- Pressure-controlled fine drainage
- low pressure gas gathering

- 三维地震
- 平台式丛式井
- 水力压裂
- 压力控制精细排采
- “低压集气、气液混输、集气站分离增压、集中处理”

Well site map of Qinshui Basin cluster well

沁水盆地丛式井井场图



Ground construction layout of Fan Zhuang block

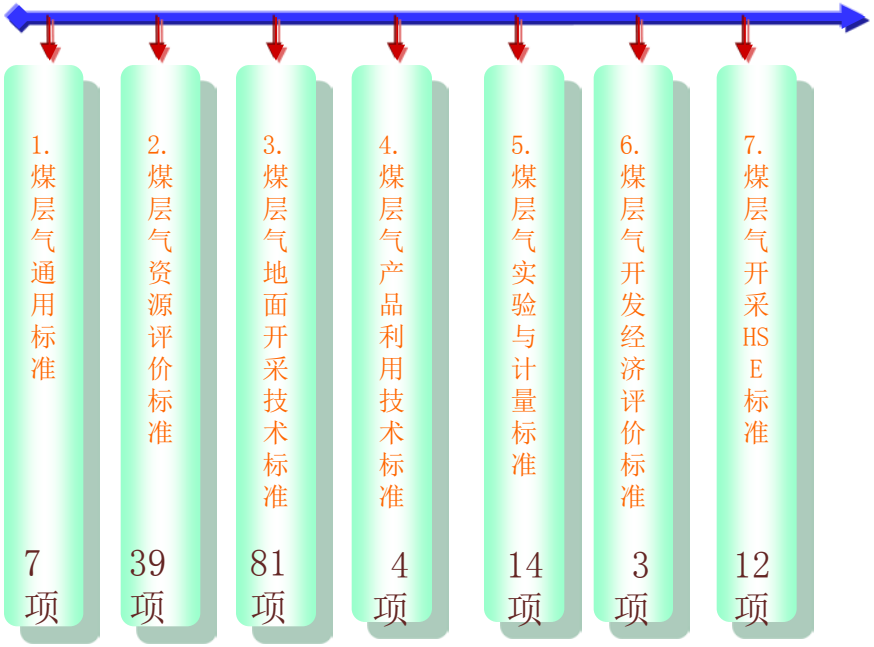
樊庄区块地面建设布局图

III. CBM standard system 煤层气标准体系

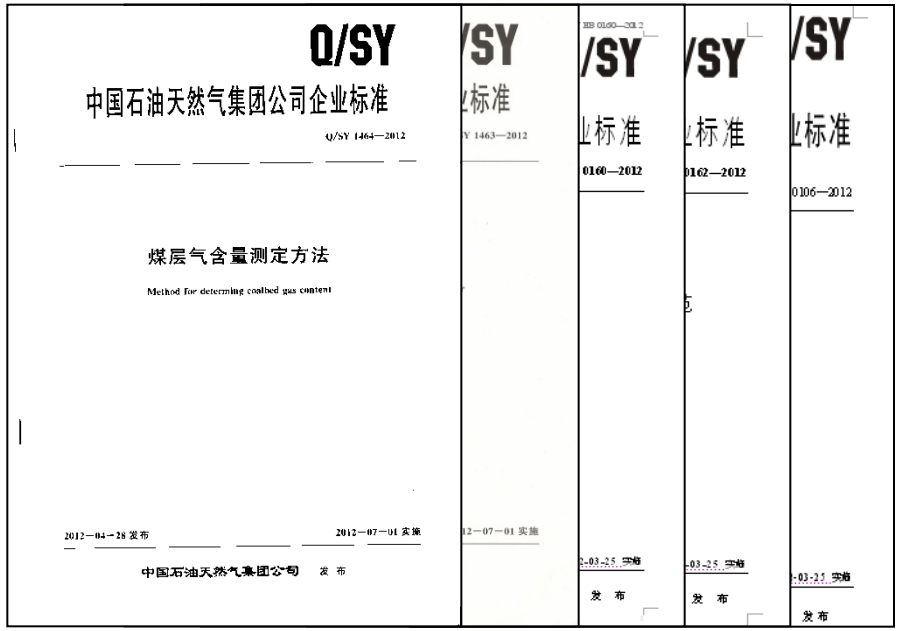
- **Compiled 160 standards for CBM**

  编制煤层气标准160项

CBM standard system framework
煤层气标准体系框架



Some standards and specification
部分标准、规范



IV. Team 生产与研发队伍

- **3 professional companies(2000people)**
  - ✓ **Huabei Oilfield Company**
  - ✓ **Coalbed Methane Company Limited**
  - ✓ **Zhejiang Oilfield Company**
- **3 professional research institutes(150 people)**
  - ✓ **CBM National Engineering Research Center**
  - ✓ **RIPED-Langfang**
  - ✓ **CBM Research Center of Huaibei Company**

3个专业公司（2000人）

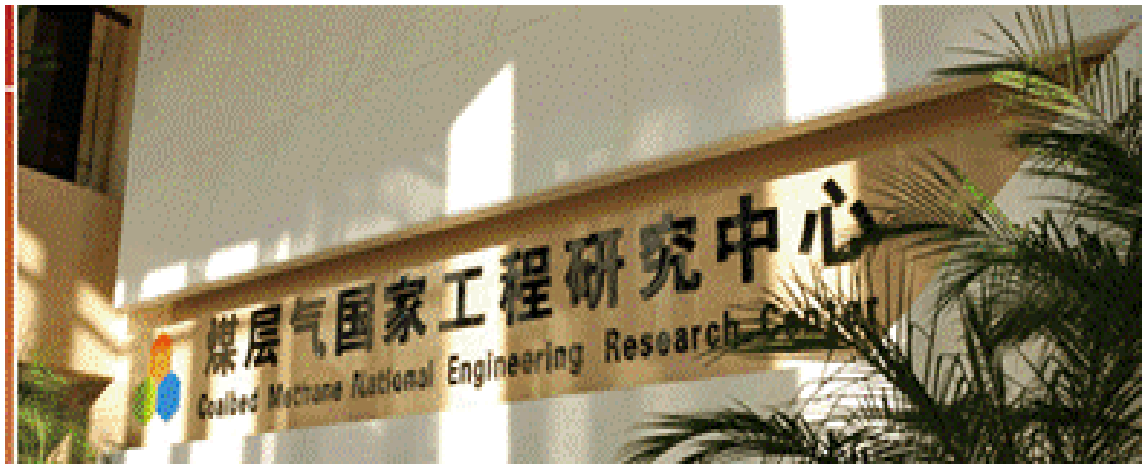
华北、煤层气、浙江

3个专业研究机构（150人）

煤层气国家工程中心

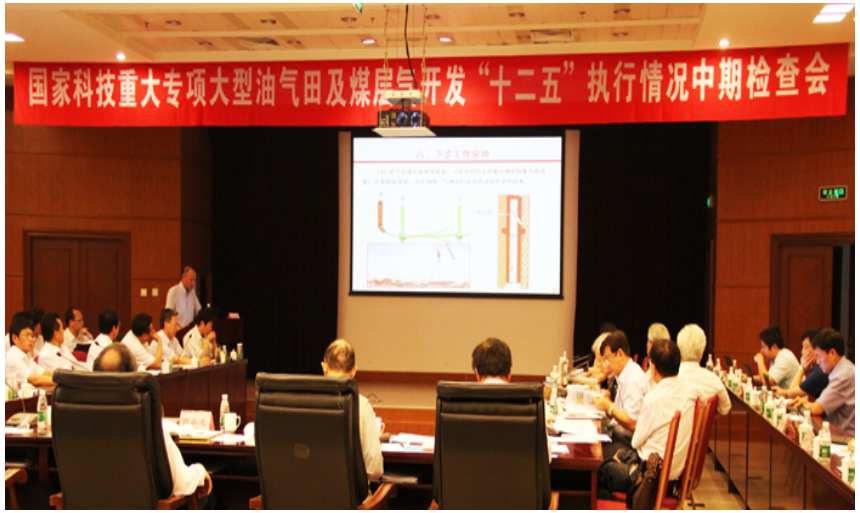
勘探开发研究院廊坊分院

华北油田煤层气研究中心



- **Lead 5 national key CBM projects and pilots**
- **Conduct CNPC CBM R&D projects**
- **Covered CBM geological evaluation, well stimulation, surface facilities, economic evaluation, HSE, etc.**

牵头承担5个国家重大专项，
中国石油设有煤层气重大科技专项，
项目涵盖煤层气地质评价、增产改造、地面工程、经济、环保等研究内容



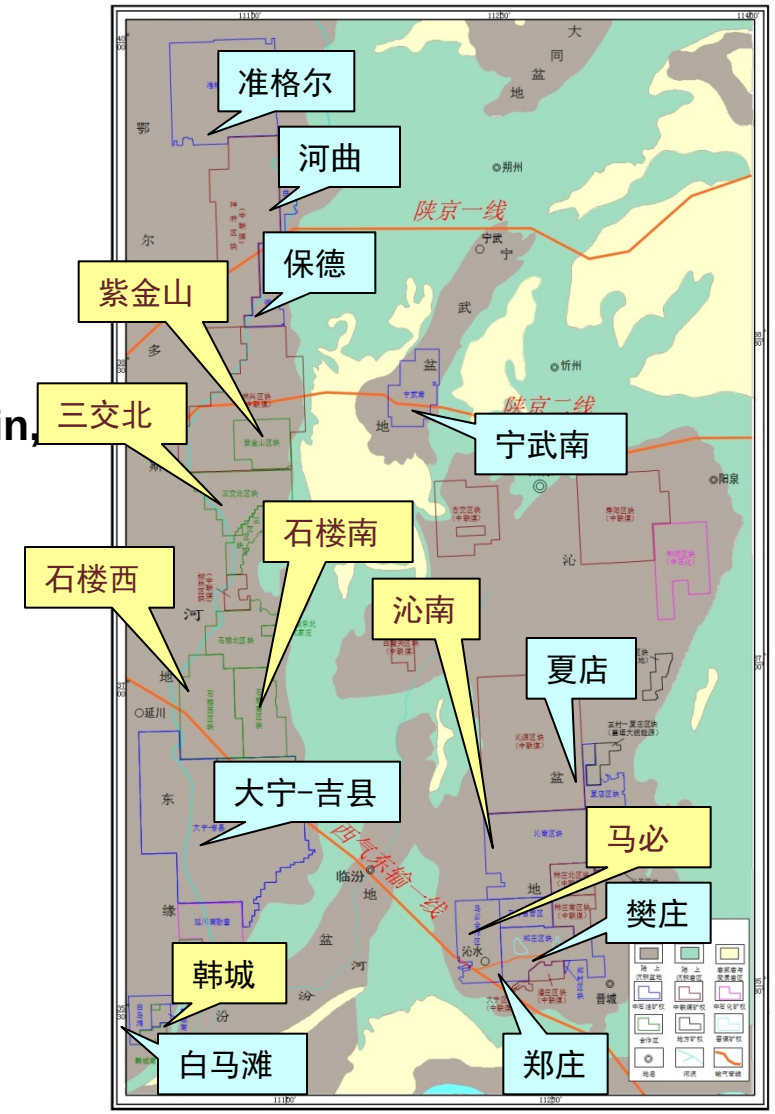
Content

Part 3 CBM Technologies and Production of CNPC

中国石油技术与生产

- **9 self-operated projects**
  - ✓Qinshui Basin and Ordos Basin
  - ✓5,738 wells with 4.5 million m3/d
- **9 international cooperation projects**
  - ✓Qinshui Basin, Ordos Basin, Junggar Basin, etc.
  - ✓200 wells with 0.6 million m3/d

- 9个自营项目位于沁水及鄂尔多斯盆地；完成钻井5738口，日产气450万方
- 9个对外合作项目位于沁水、鄂尔多斯、准噶尔等盆地;完成钻井200余口，日产气60万方



China major CBM block distribution

中国石油主要煤层气区块分布图

Case 1: Fan Zhuang block (High rank)

樊庄高煤阶

- **Depth: 240-809m(3 #); 400-900m(15 #)**
- **Ro: 2.6 -3.8%, anthracite**
- **Permeability: 0.01-0.5 md**
- **Proved reserves: 35.2 billion m^3**

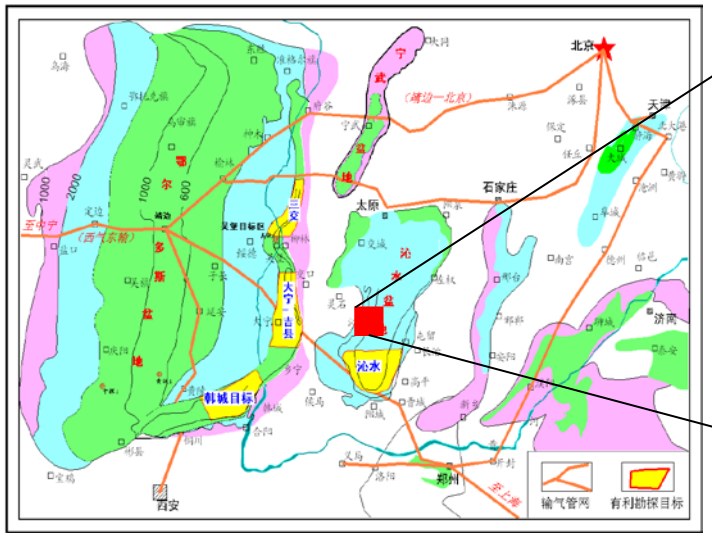
➢ Basic data

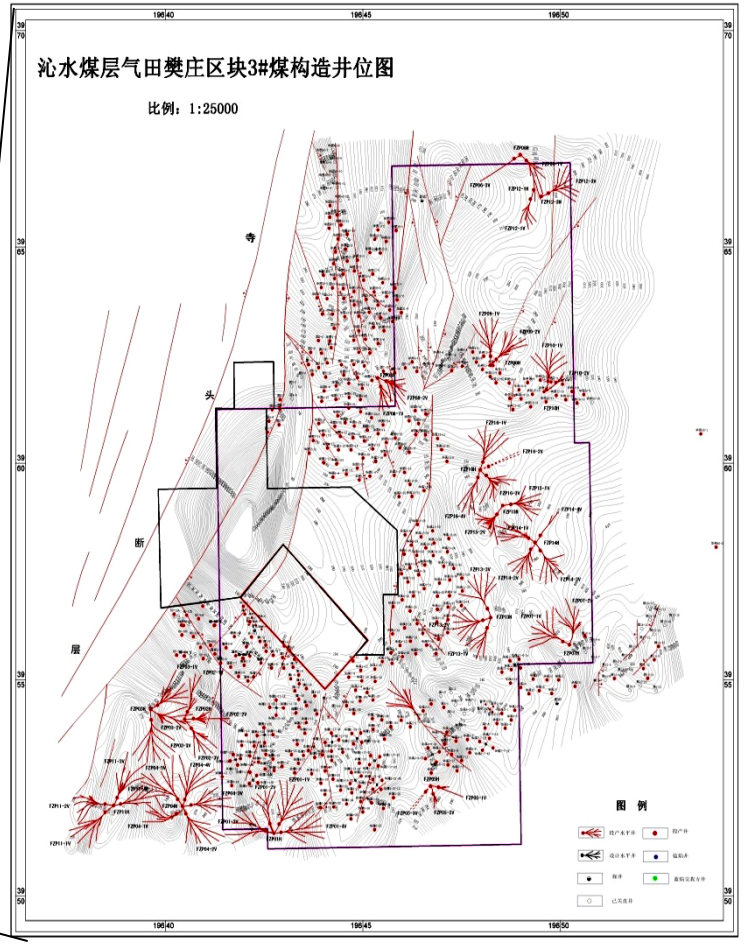
埋深：3#煤240-809m，15#煤400-900m

煤阶：Ro 2.6—3.8%，无烟煤

渗透率：0.01-0.5md

探明储量：352亿方

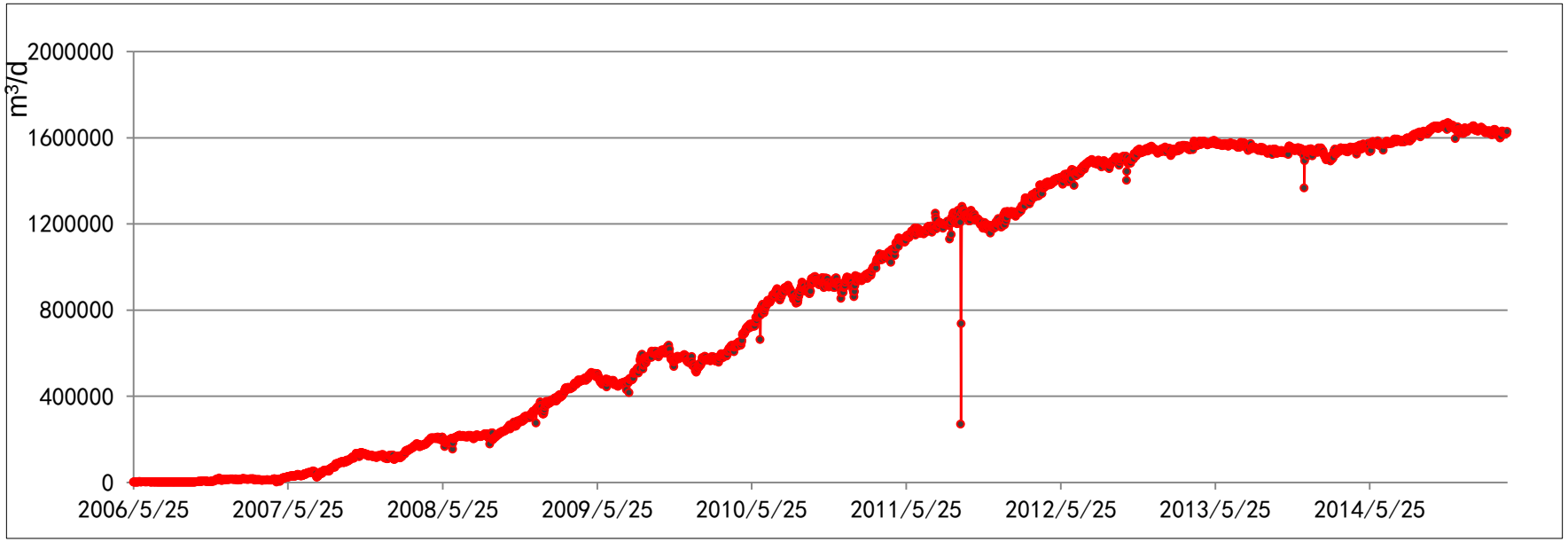




Development status 开发现状

- Productivity:800 million m^3 /year
- Production(2014): 600 million m^3
- producing wells: 761
  - ✓ 708 vertical wells:1,800 m^3 /day /well
  - ✓ 53 horizontal wells: 7,000 m^3 /day /well

产能8亿立方米/年，2014年产量6亿立方米；生产井761口（含水平井53口）；直井单井平均日产1800方，水平井单井平均日产7000方



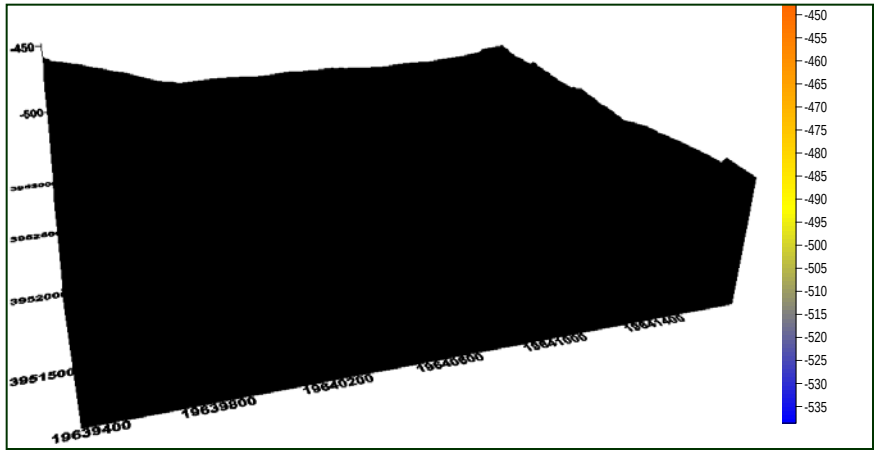
production curve of Fanzhuang block

樊庄区块综合生产曲线图

Technologies 主要勘探开发技术

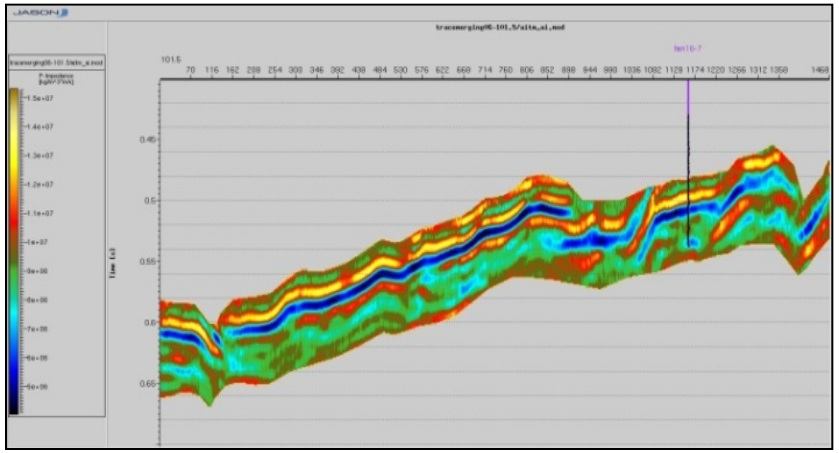
- Experimental test
- Sweet spot forecast
- Well bore trajectory optimization
- Horizontal well drilling and completion
- Coal seams protection

- 实验测试和地质评价技术
- 甜点区预测技术
- 井身轨迹优化技术
- 水平井钻完井技术
- 煤储层保护技术



Trajectory design, drilling and completion technology of horizontal well

水平井井眼轨迹设计与钻完井技术



Forecasting technology for high permeability gas reservoir

富集高渗储层预测技术

Case 2: Baode block（low rank） 保德低煤阶

- Depth: 300-1,200m.
- Ro: 0.45-0.9，gas coal, fat coal
- Permeability：2.5-12md
- Resource: 98.3 billion m^3

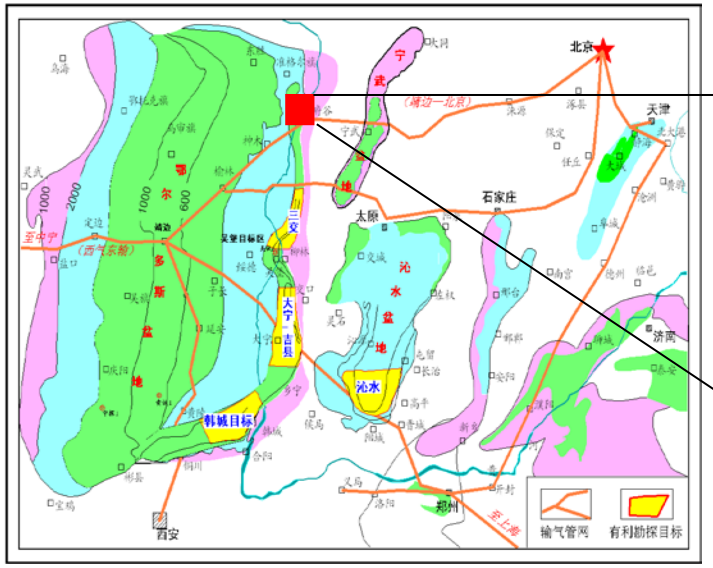
埋深：300-1200m，

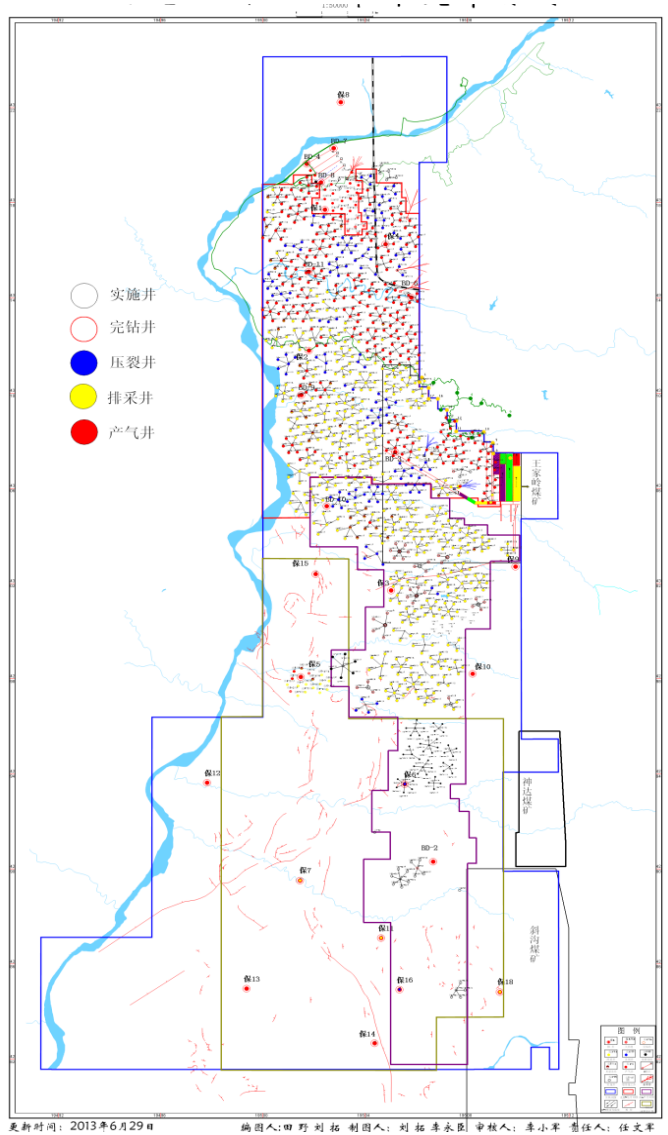
煤阶：气、肥煤，

渗透率：2.5-12md

资源量：983亿m^3

➢ Basic data



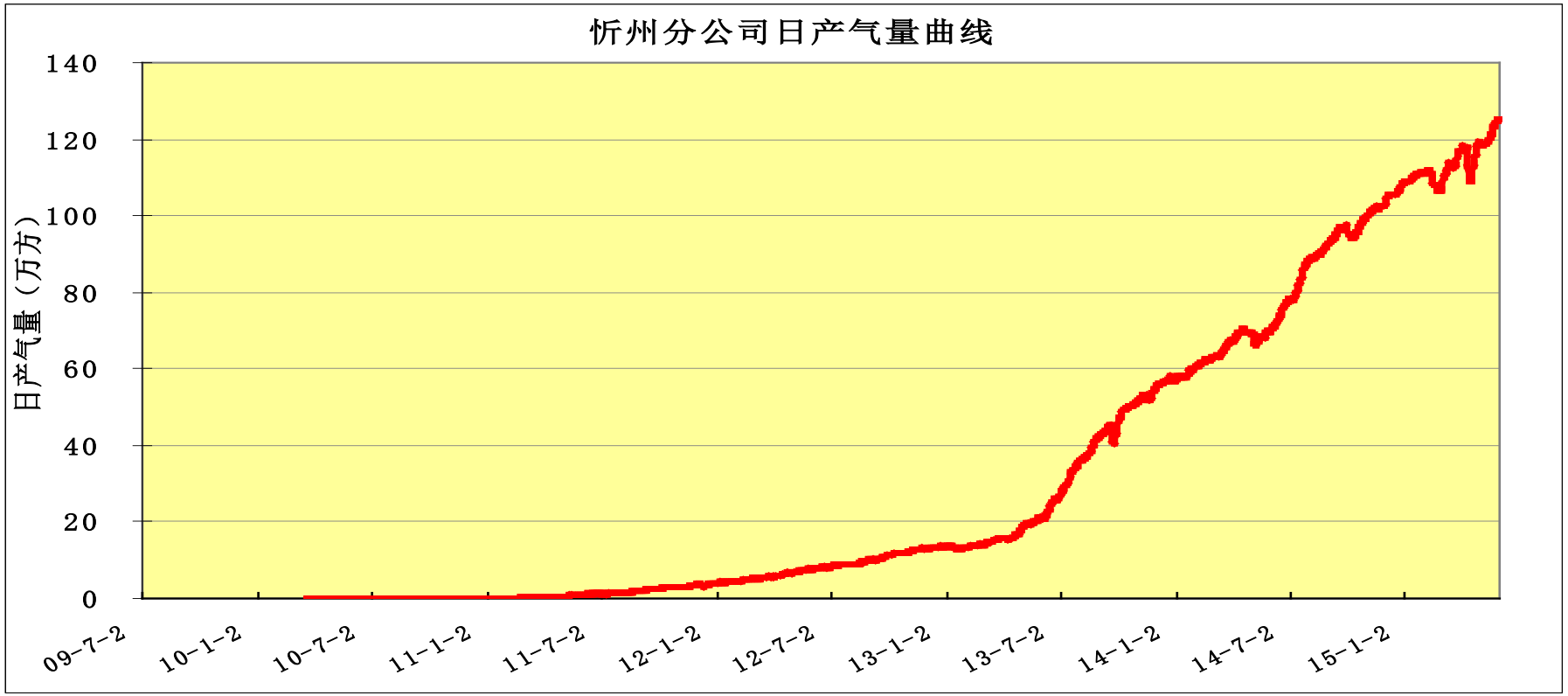


Development status 开发现状

- Productivity:500 million m^3 /year
- Production(2014): 300 million m^3
- producing wells: 673 vertical wells, 1,300 m^3 /day /well

产能5亿立方米/年，2014年产量3亿立方米

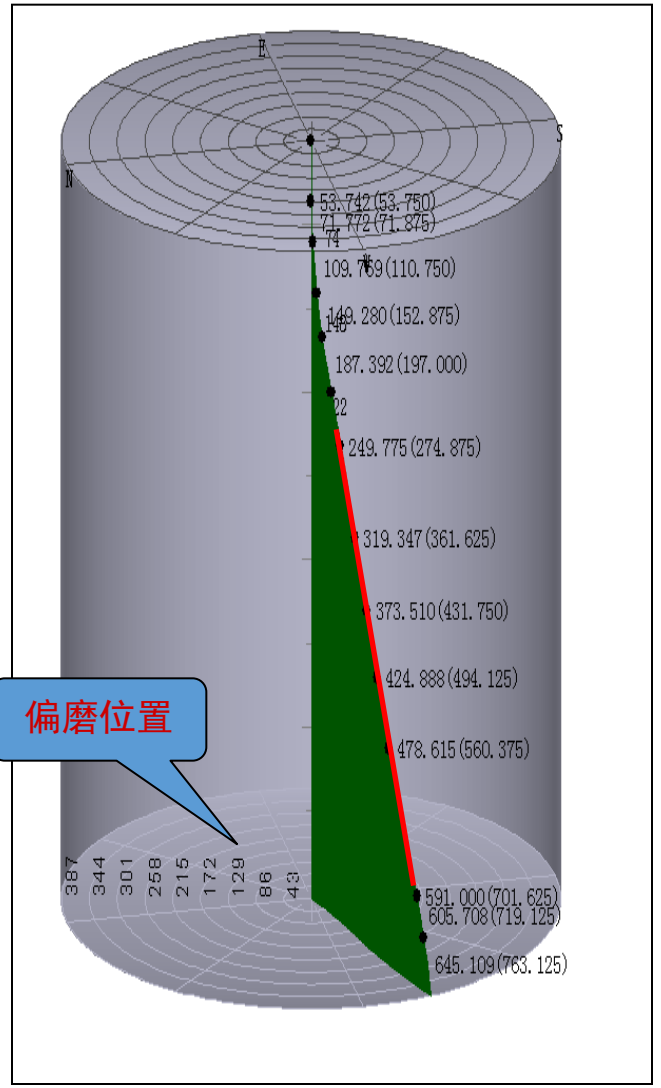
生产井673口直井，单井平均日产2000方



Technologies 主要勘探开发技术

- **Sweet spot forecasting** 甜点区预测技术
- **Cluster well drilling** 平台式丛式井钻井技术
- **Eccentric wear prevention** 防偏磨技术
- **Automated drainage** 自动化排采技术
- **Produced water treatment** 采出水处理技术

Water treatment station
水处理站



Well trajection of Bao1-3
保1-3向3井井身轨迹

Content

Part 4 CBM Challenges in China

煤层气产业挑战展望

I. Challenges 挑战

Challenge 1 - Geology

- Three intensive tectonic movements in Northern China
- Tectonic coal accounting for a quarter of the total resources

挑战1 – 地质条件相对复杂

华北地区经历3次强烈构造运动

构造煤占总资源量四分之一

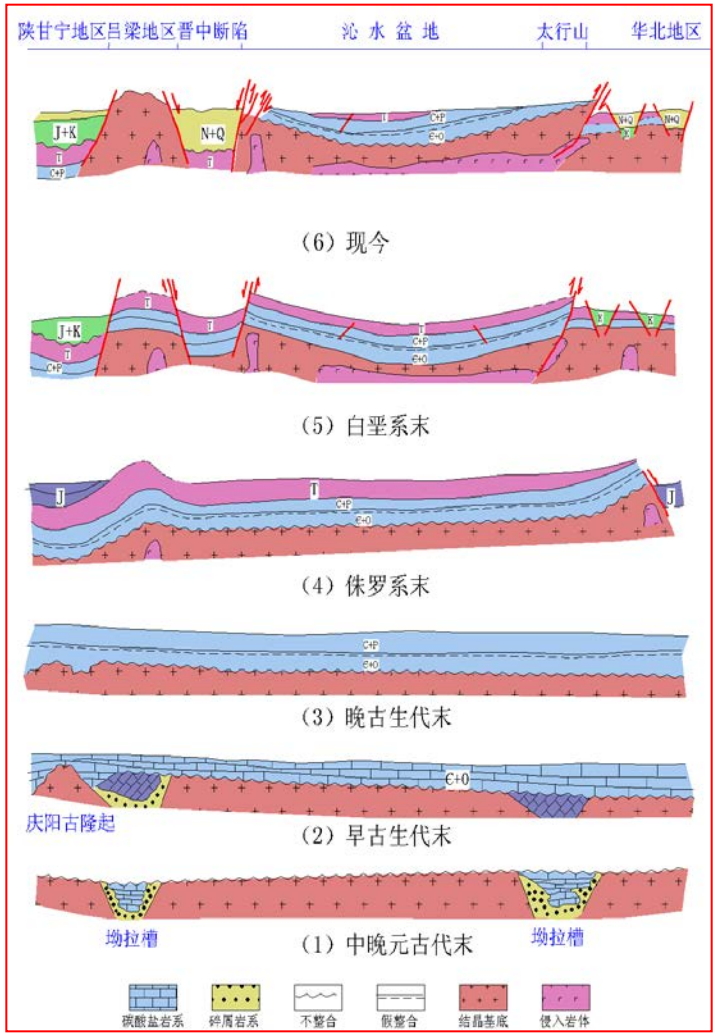
碎斑煤

揉皱煤

碎粒煤（糜棱煤）

Tectonic Coal with Different Structures

不同结构构造煤



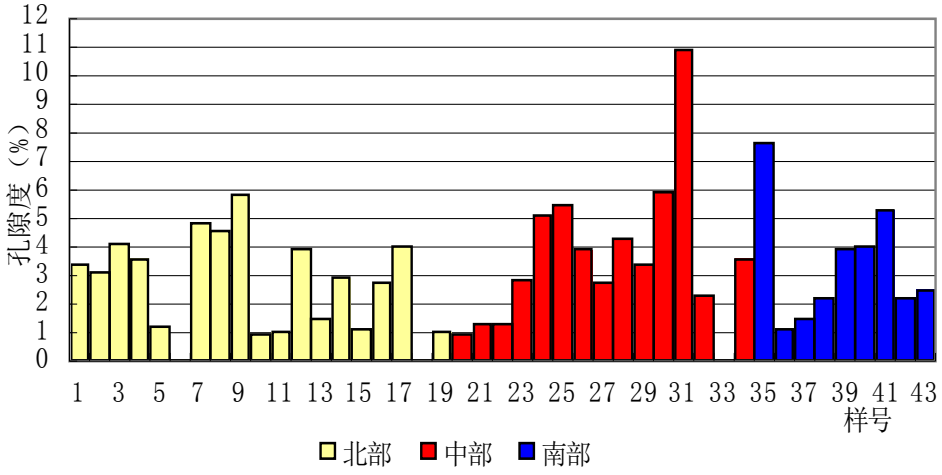
Tectonic Evolution Scheme of Craton Basin, Northern China

华北克拉通盆地构造演化示意图

- **Porosity：** less than 5%;
  Connectivity：poor, cleats mainly filled by minerals
- **Permeability：**averaged at 0.97md;

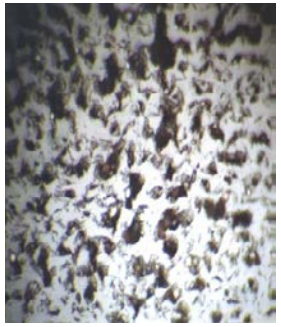
孔隙度一般不足5%，且连通性较差，割理多被矿物充填

渗透性0.002～16.17 md，平均为0.97md，小于0.1md占35%， 0.1～1md的占37%



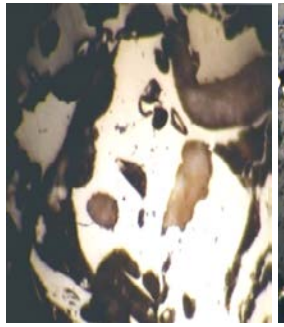
The actual measured porosity of Qinshui basin(< 3.5%, bad connectivity)

沁水实测平均孔隙度不足3.5%，且连通性差



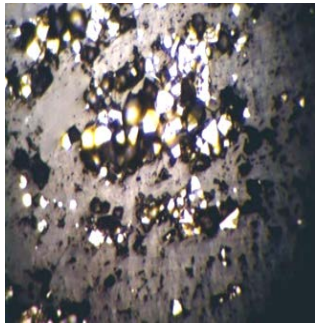
Primary Pores

原生胞腔孔



Chip Clearance

屑间孔



Intergranular Pores

矿物粒间孔

Challenge 2 - Technologies

- Low cost
- Applicable to specific targets
- Large-scale application

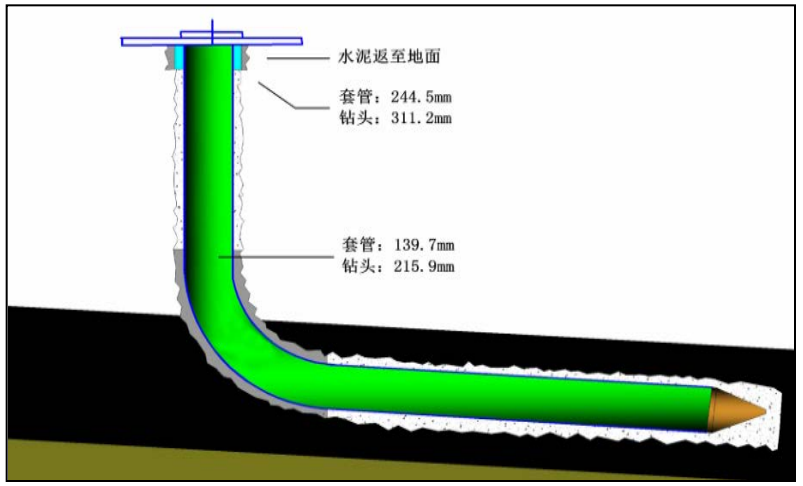
e.g.

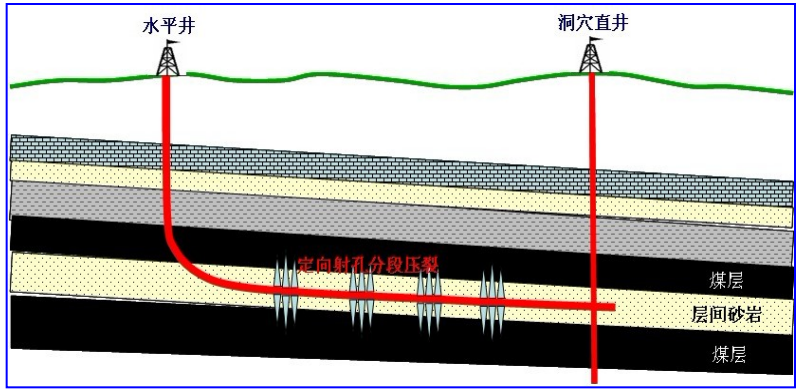
✓ mono-lateral horizontal well drilling with screening pipe completion

✓ low volume pad fluid fast flowback fracturing

挑战2：开发技术有待持续完善

低成本的、针对性的适用勘探开发技术规模化应用才能降低煤层气勘探开发成本，如筛管完井的单支水平井技术、低前置液快速返排压裂工艺等





Fracturing Stimulation Test in Horizontal Well along Roof and Floor

沿煤层顶底板水平井压裂增产改造试验

Challenge 3 - Environment

- Drilling and fracturing fluids during development
- Produced Water, estimated volume of 8,000 m^3/d of total wells domestic.
- lEnforced the newly revised Environmental Protection Law of the PRC On Jan. 1, 2015

挑战3：环保

- 建产过程中的钻井液、压裂液；生产过程中的产出水
- 2015年1月1日开始实施新修订的《中华人民共和国环境保护法》

II. The Way Forward 展望

Facing demand-supply gap and environment protection pressure in China, CNPC will further promote the CBM development for energy structure optimization and greenhouse gas emission reduction. We will keep on enhancing technical breakthrough to realize stable development of CBM business and are willing to cooperate with all interested companies from energy industry to face these challenges, to speed up CBM E&P and meet natural gas demand in China, that will contribute to global gas industry as well.

中国天然气供需矛盾日益突出，环境压力日趋加大，煤层气开发利用有利于改善中国的能源结构、增加洁净气体能源；有效减少温室气体的排放、改善大气环境。中国石油将不断加大煤层气研发力度和勘探开发投入，同时欢迎国际同行与我们携手面对挑战，加快煤层气勘探开发进程，为煤层气产业的发展做出贡献

Thank You !

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