



CO₂-ECBM Project in China

CUCBM
CNOOC

2013. 10. 19



OutLine

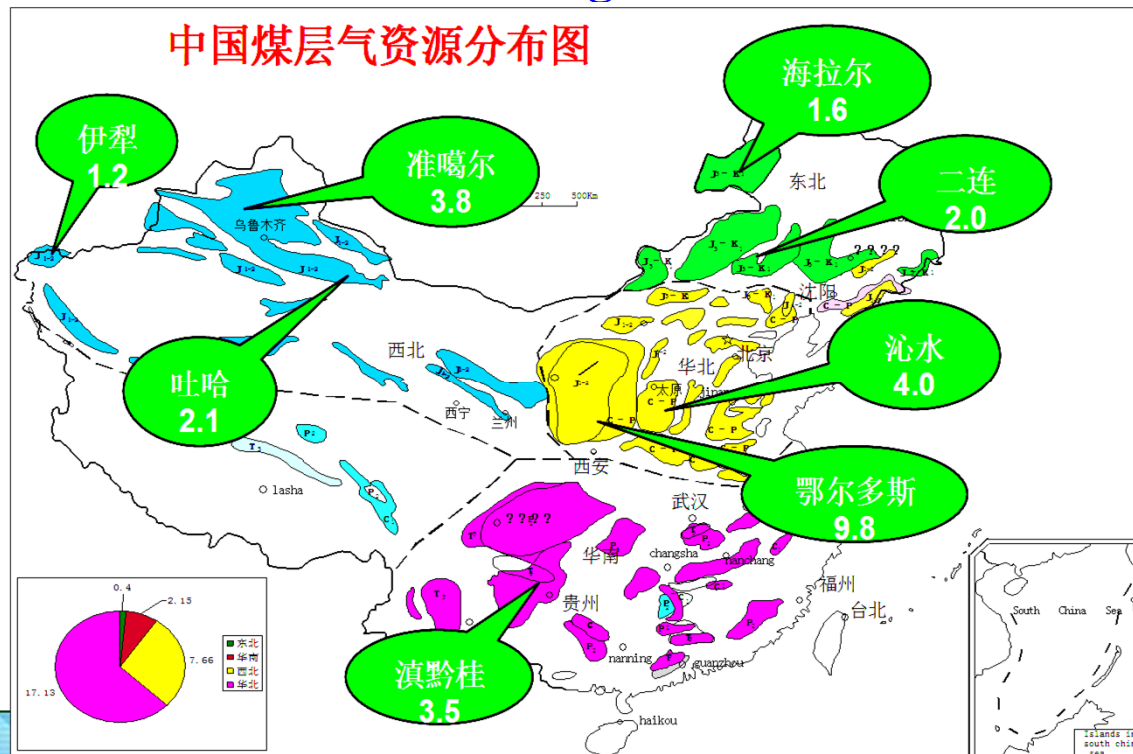
- 1. China's CBM resource potential**
- 2. Situation of CO₂-ECBM in China**
 - (1) TL-003 pilot project**
 - (2) SX-001 pilot project**
 - (3) Horizontal well pilot project**
 - (4) Deep coal and well group pilot project**



A huge amount of coalbed methane resources

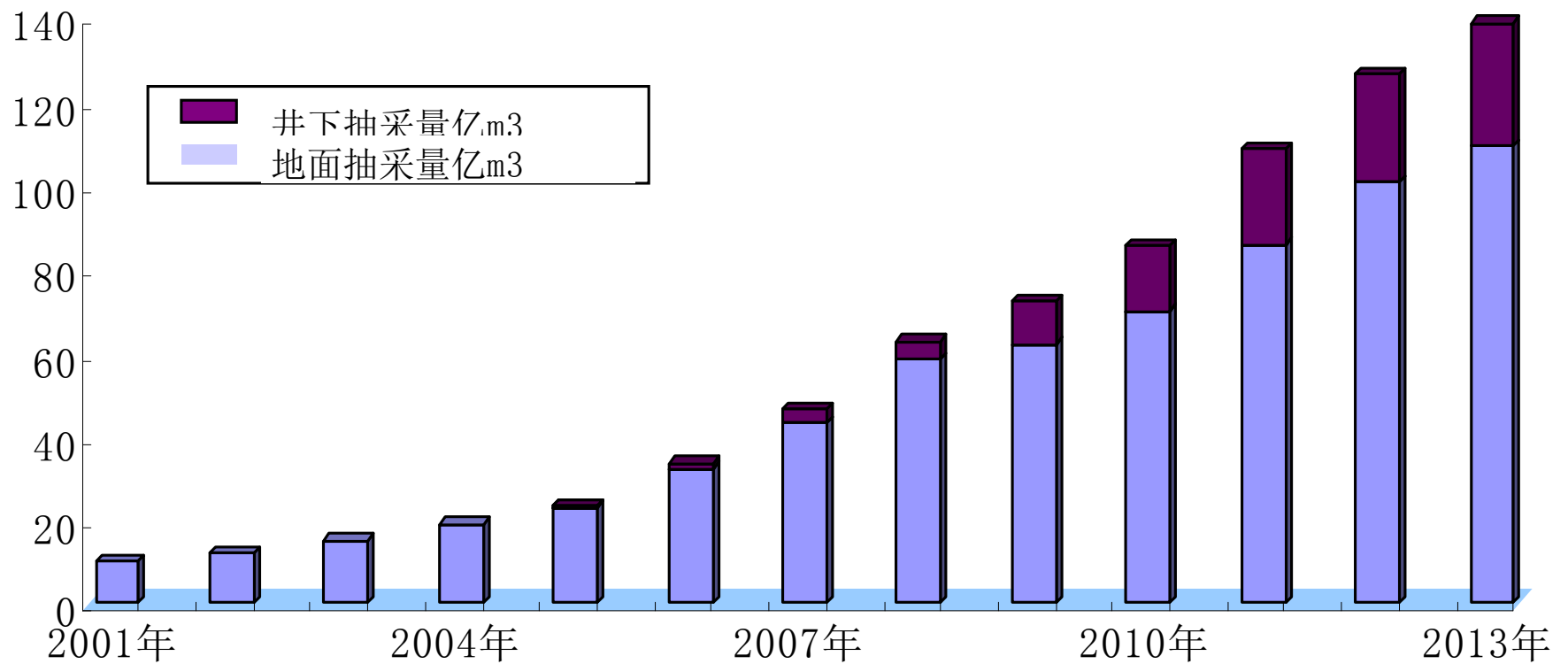
■ CoalBed Methane

- CBM commonly known as " gas " is assigned in the coal seam. It is a clean energy, national resources amounted to 36.8 trillion cubic meters in China, equivalent to conventional natural gas . It is most realistic supplement energy .





Coalbed Methane Gas Production Increased Year by Year



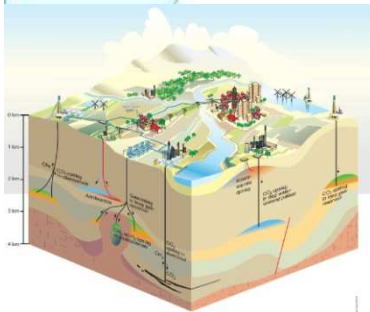


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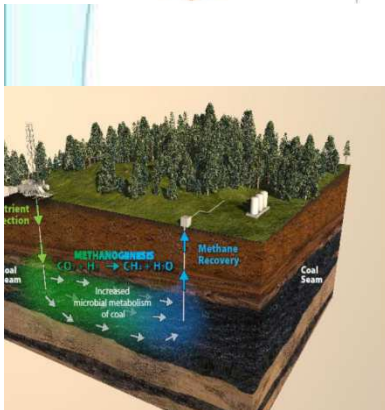
CCS Technology



CO₂ Capture



CO₂ Transport



CO₂ Sequestraion

ECBM

EOR

Aquifer storage

Political

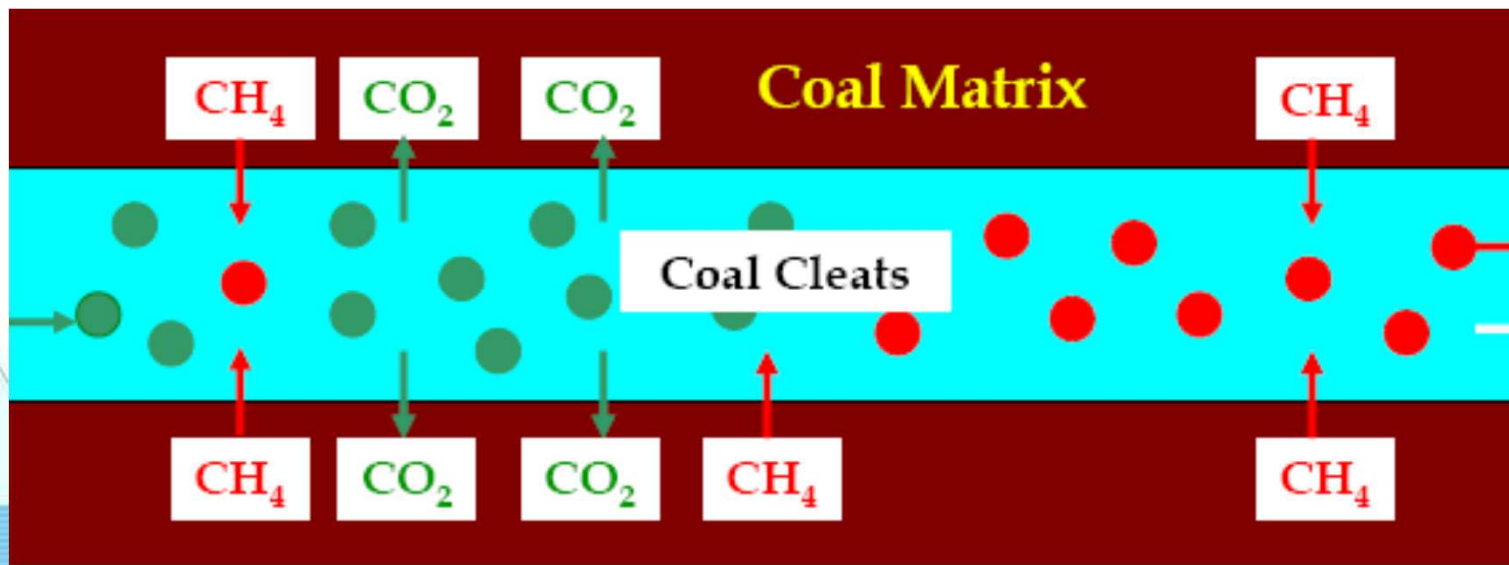
Environmental

Economal



CO₂-ECBM

- ◆ Carbon dioxide injected into the coal bed for methane (CO₂-ECBM) production technology means :
- ◆ CO₂ is more easily to be absorbed to the coal bed surface, replace more methane by injecting a certain amount of carbon dioxide, so as to improve the Gas production of coal bed well and recovery degree.



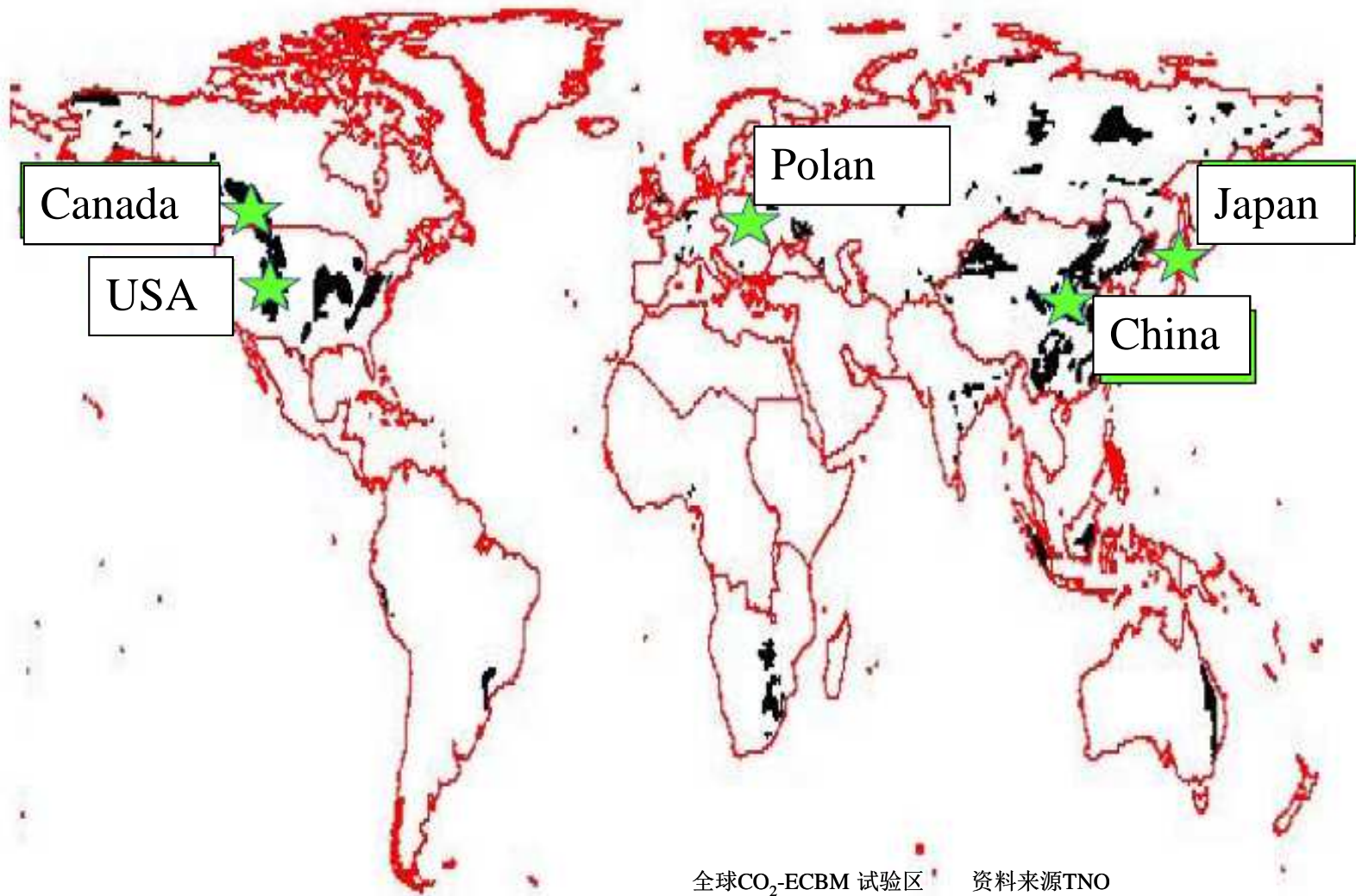


Abstract

- ◆ At present, carbon dioxide is injected into the coal bed and enhanced coalbed methane production technology has been developed to the group well test stage.
- ◆ Test results around the world have shown that the technique can improve the CBM production and coal bed methane recovery, carbon dioxide can be sequestration.
- ◆ In China, base on the southern Qinshui Basin single well test, laboratory test results and numerical simulation. We believe that the 3 # coal seam after injection of carbon dioxide, coal bed methane recovery degree increase above 10%.



Global CO₂-ECBM project



全球CO₂-ECBM 试验区 资料来源TNO



China CO₂-ECBM project

Only in China United Coalbed Methane Company conducted the field test , field test sites are in Shanxi Province .



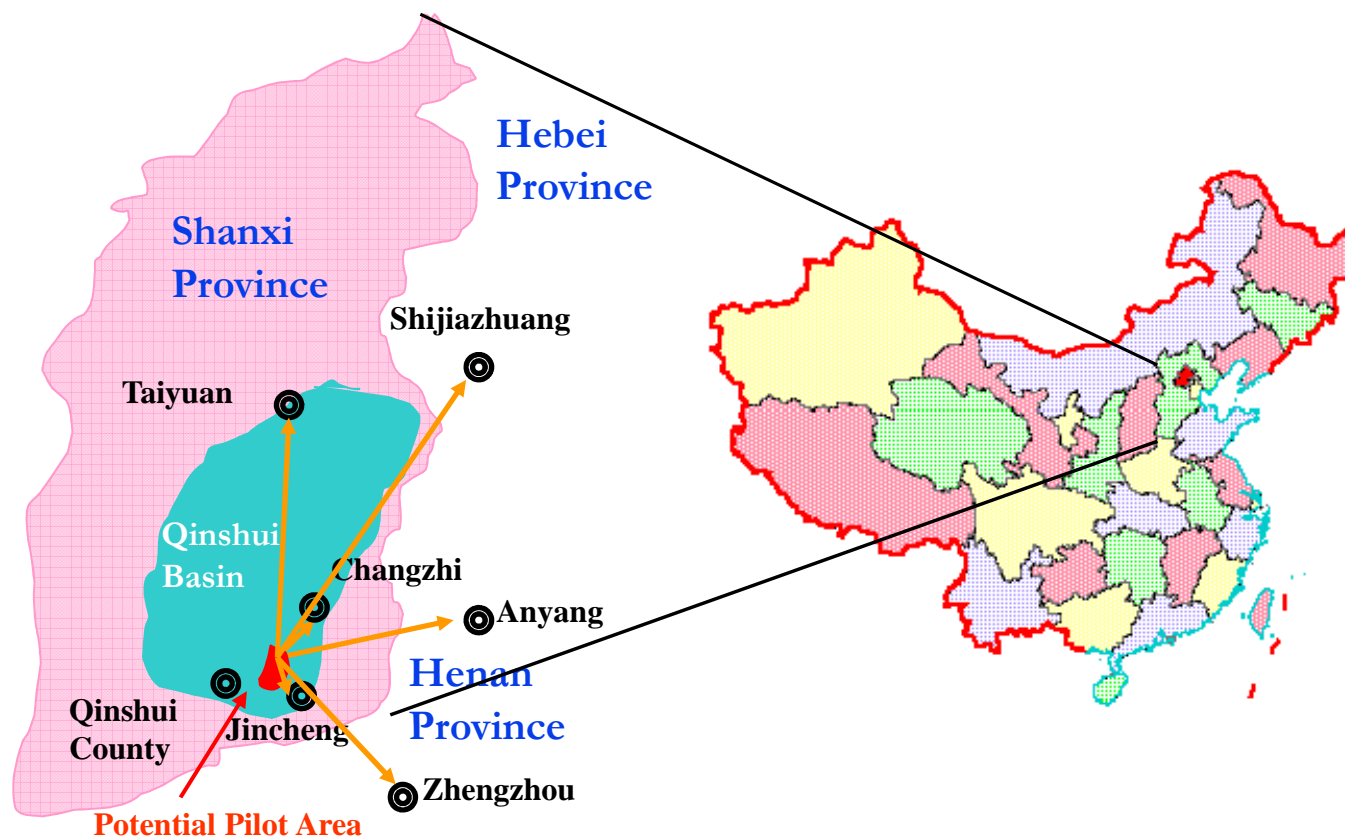


CO₂-ECBM Field Test

- ✓ 2004 , shallow coal seams injected CO₂ increasing coalbed methane pilot single-well micro -type test ; (**single well**)
- ✓ 2007, "deep coal injection / extraction study of coalbed methane buried CO₂ technology" single-well micro- pilot test ; (**deep coal seams single well**)
- ✓ 2010 , horizontal wells increase gas injection project . (**Horizontal well**)
- ✓ 2011-2015 , "deep coal seam methane injected CO₂ displacement technology research and equipment development " (**deep coal seams well group test**)



(1) 2004 , TL-003 field test





(1) 2004 , TL-003 field test



bottomhole pressure
and temperature
monitoring system :



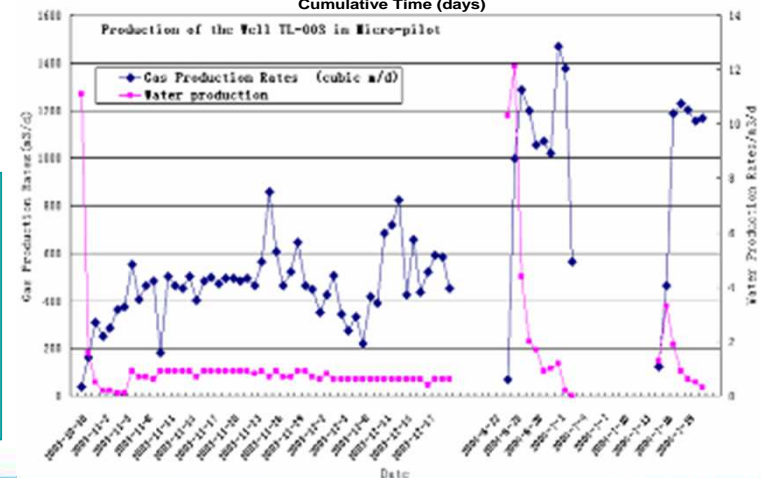
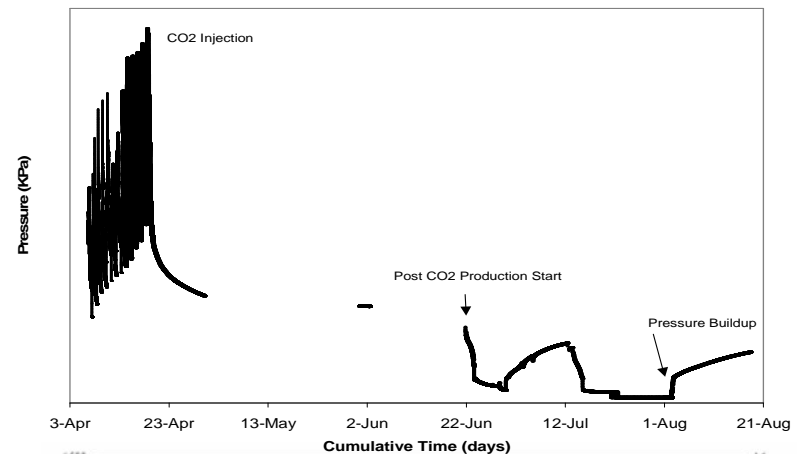


(1) 2004 , TL-003 field test



■ Production rate increase after inject CO₂.

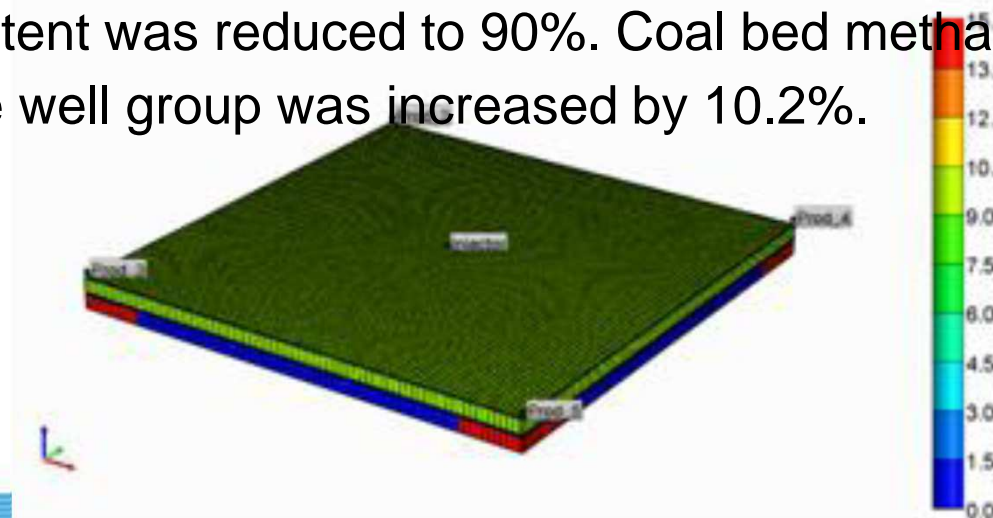
■ CO₂ can be buried effectively





Simulation

- ◆ CMG was applied for numerical simulation. Use a well geological parameters. The model used 5-point method to arrange 5 wells, and the distance between production wells is 500m .
- ◆ In the model, center well is the production well in the early stage. During the process of enhancing coal bed methane recovery, it was CO₂ injection well. The production will increase after two years. Until 7 years, the gas production quickly increased to 15000m³/d, while the methane content was reduced to 90%. Coal bed methane recovery degree in the well group was increased by 10.2%.

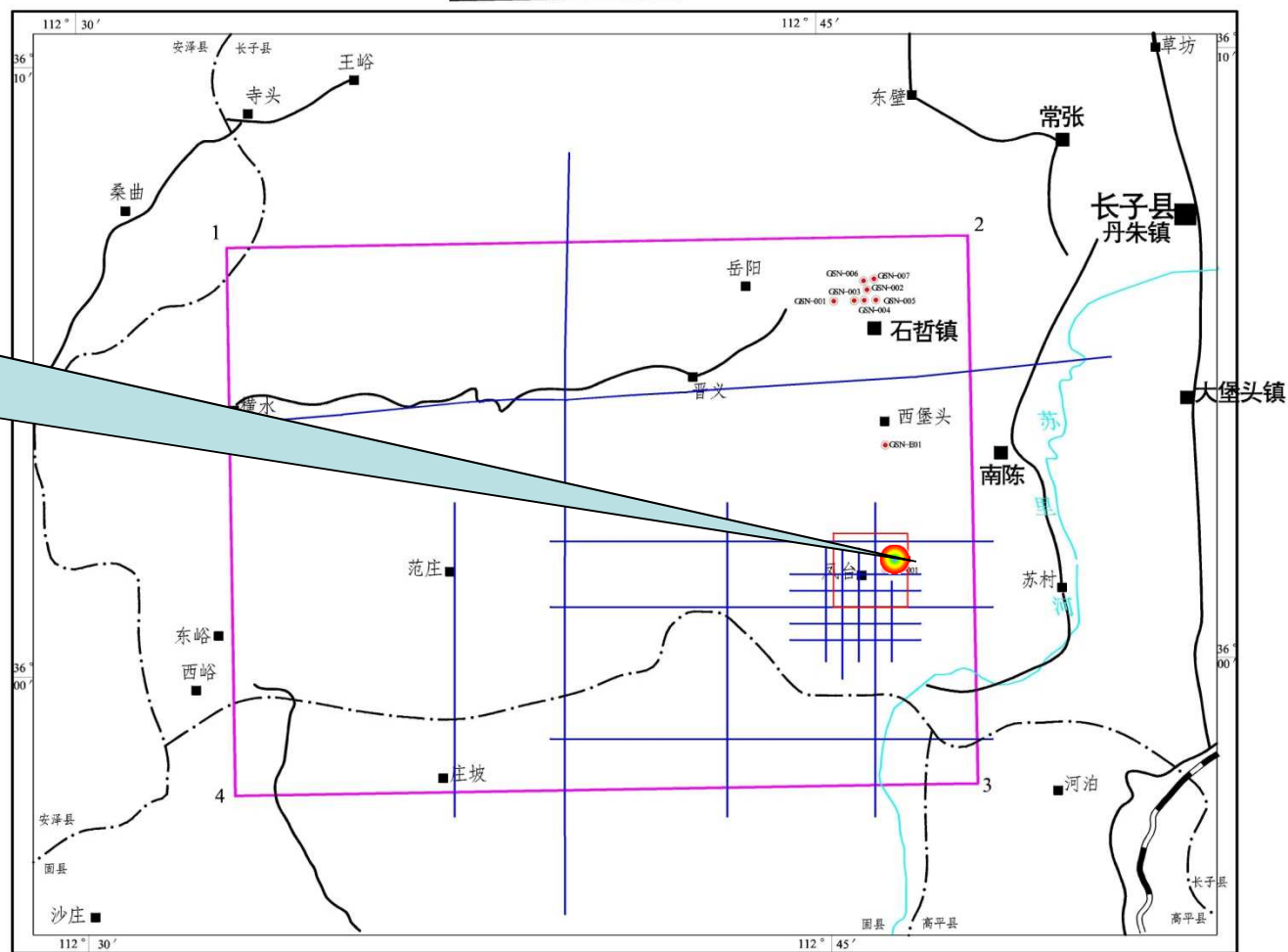




(2) 2007 , SX-001 field test

Location of SX-001

san
village,Zha
ngzi
county
Shanxi
Provence



situation of SX-001

Well bore Configuration - Injection

Surface data recording:
press./temp. transducers:
Production - on casing annulus
Injection - on tubing

14 MPa (2029 psi) Tubing-head and valves

- To be replaced with well head equipment rated to at least 21 MPa before start of pilot.



Coal Seam # 3 is located at 923m

Top of THF to KB = 1.3 m

139 mm (5 1/2") J-55
production casing at 1091 m KB
wall thickness 7.72 mm

244.5 mm (9 5/8") J-55
surface casing at 38.49 + 3.28 m KB
(surface casing subsidence, added 3.28 m)
wall thickness 8.94 mm

Cement Top @ 438.8 m KB

73 mm (2 7/8") J-55 9.6 kg/m production tubing

Tubing connectors to be replaced with gas-tight
connectors:
- TKC Convertible EUE 8rd (see brochure)
OR
- TKC Plus EUE 8rd (see brochure)

Magnetic casing
pup joint
@ 909.4 - 911.6 m KB

73 mm perforated pup joint

NOGO seating nipple (tandem memory gauges)
(Landed at or above perforations)

Coal Seam #3 perforations at 923.45 to 929.5 m KB

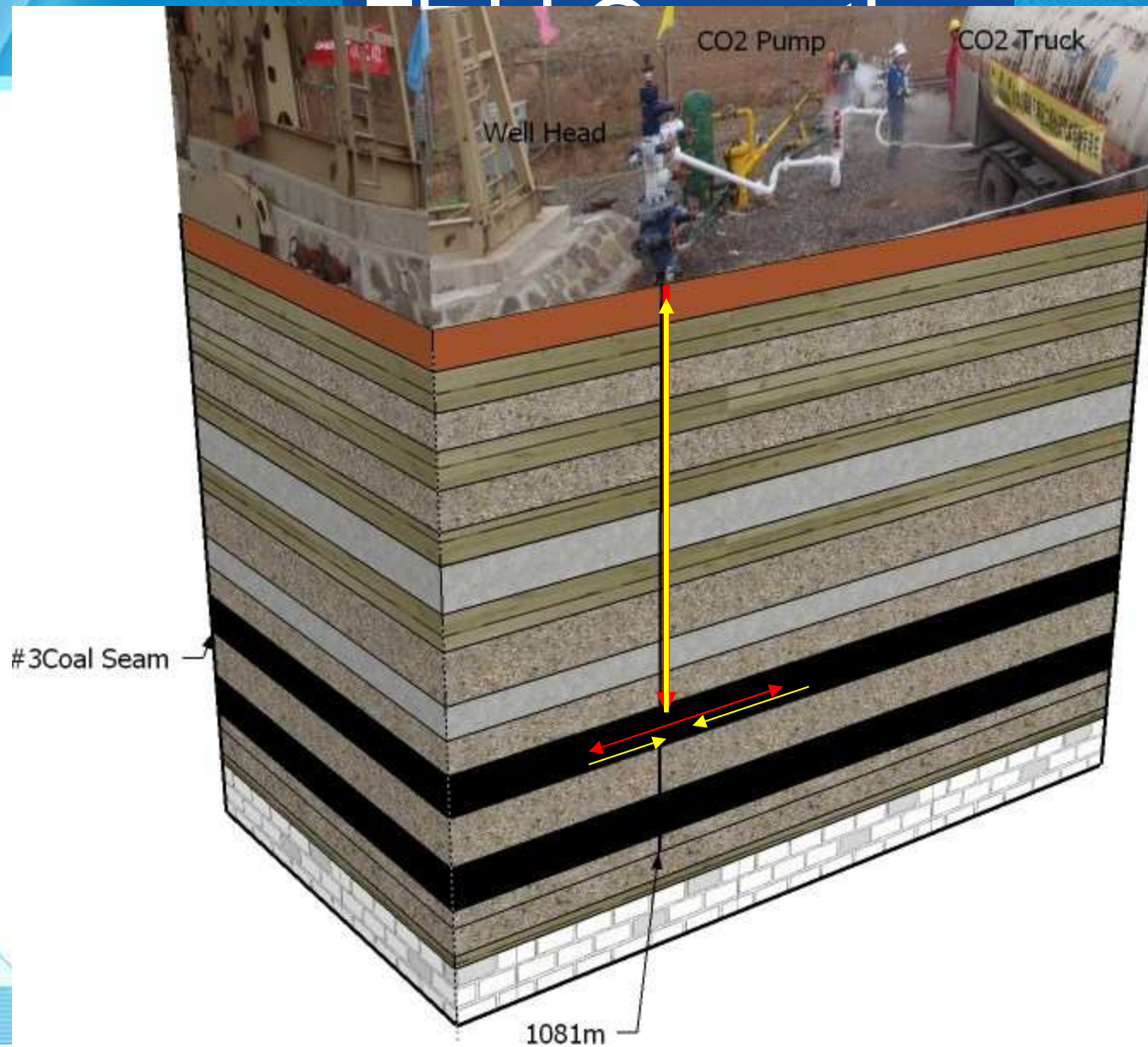
3 Coal Seam

15 Coal Seam

Coal Seam #15 No perforations

PBTD at 1081 m KB

CHOC





Field Operation



CO₂ pumping connection



Pumping CO₂

234 tonnes of CO₂ has been injected into coal seam #3



Field Operation



Measure:

- Gas rates
- Water rates
- Gas compositions
- Downhole P & T

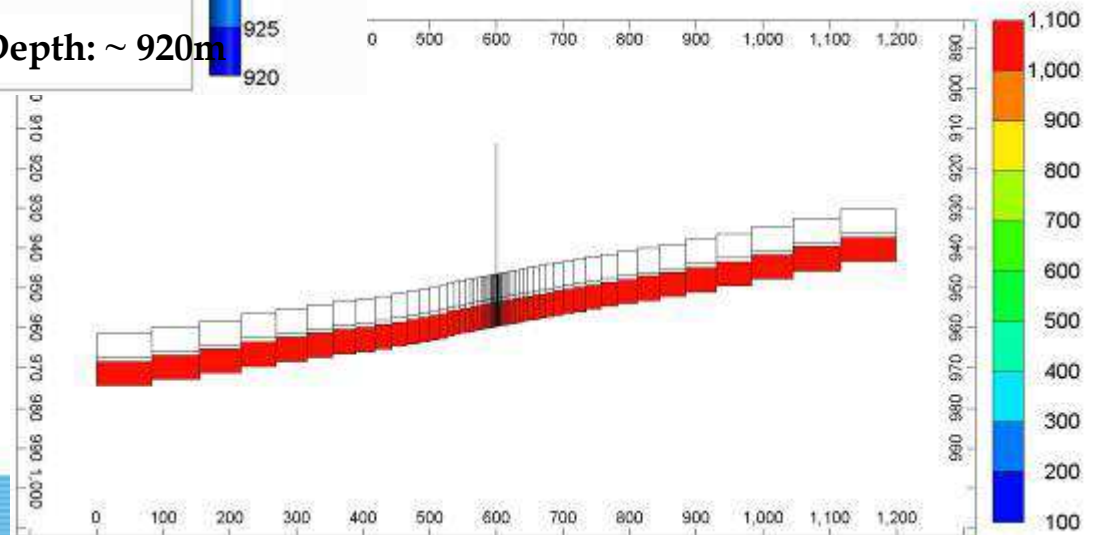
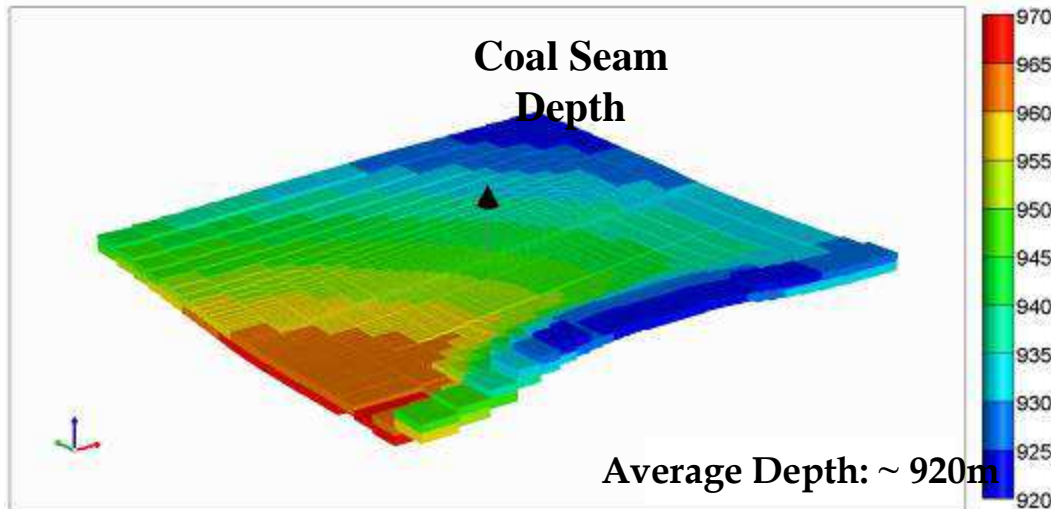
GC to measure gas
composition Of produced gas



Reservoir simulation

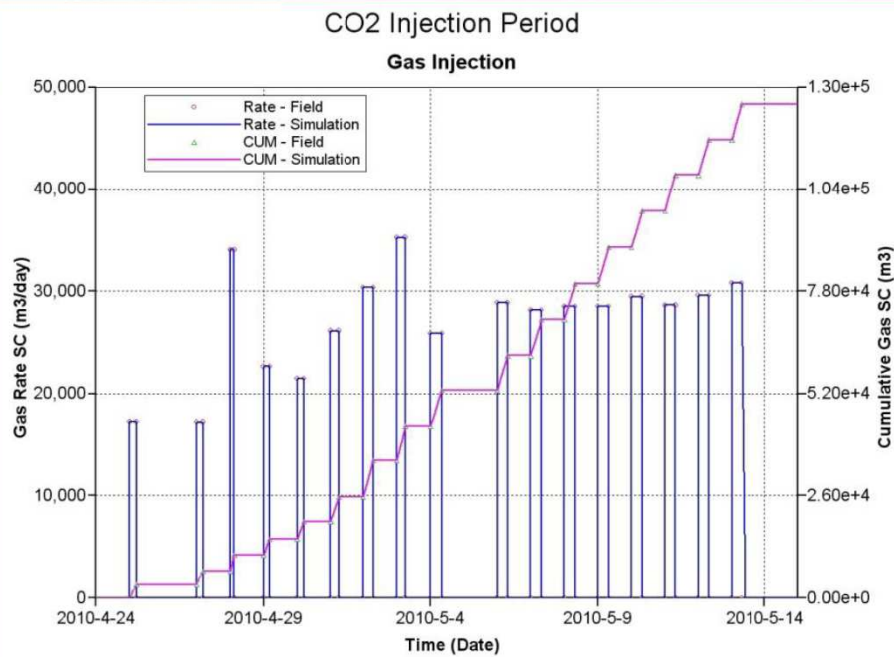
Region of Investigation:
1200m × 1200m

Grid Blocks Numbers :
63 × 63 × 3



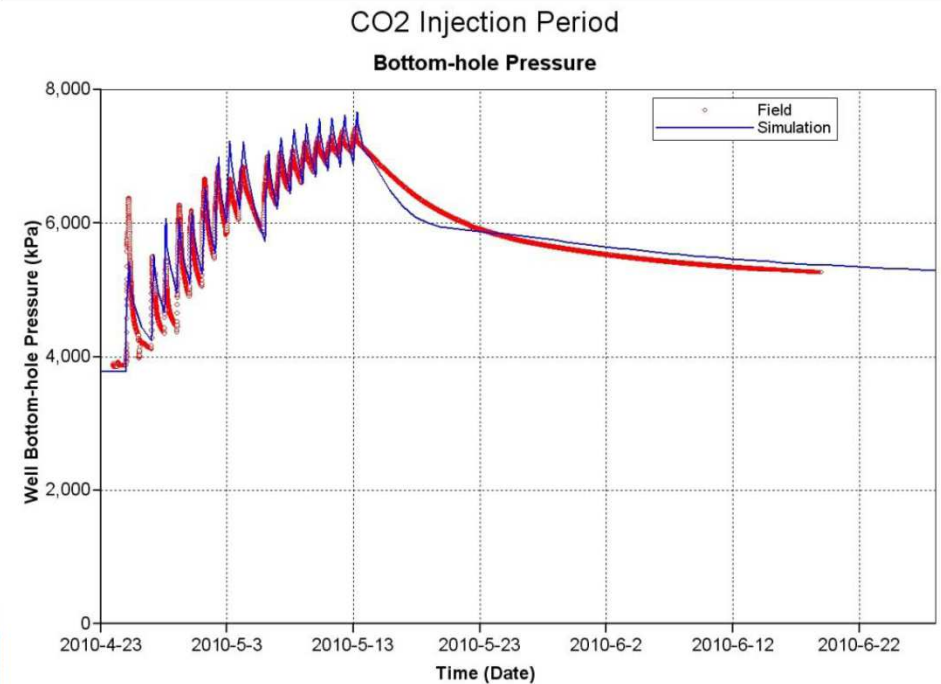


Reservoir simulation



234 t CO₂ injected

Bottom-hole Pressures

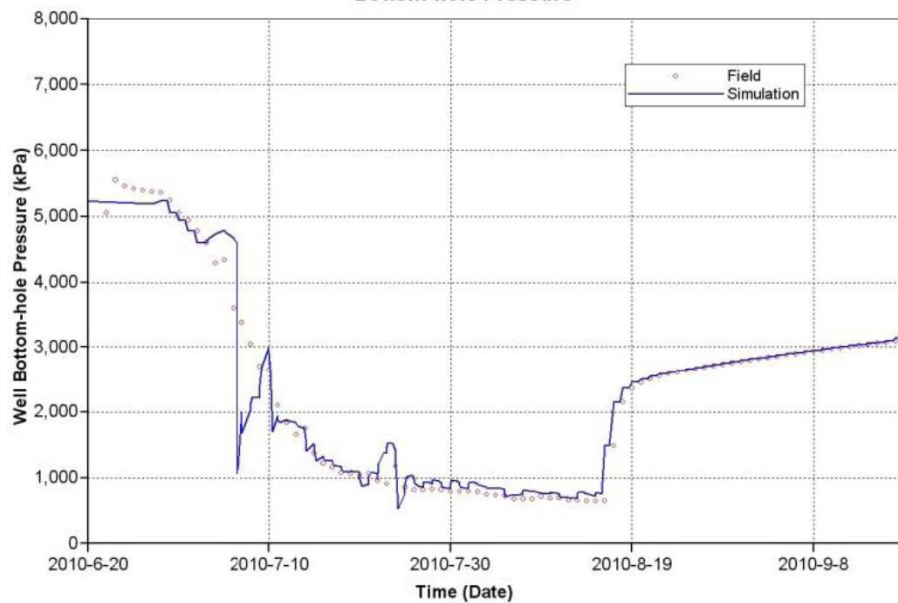




Reservoir simulation

Third Production Period

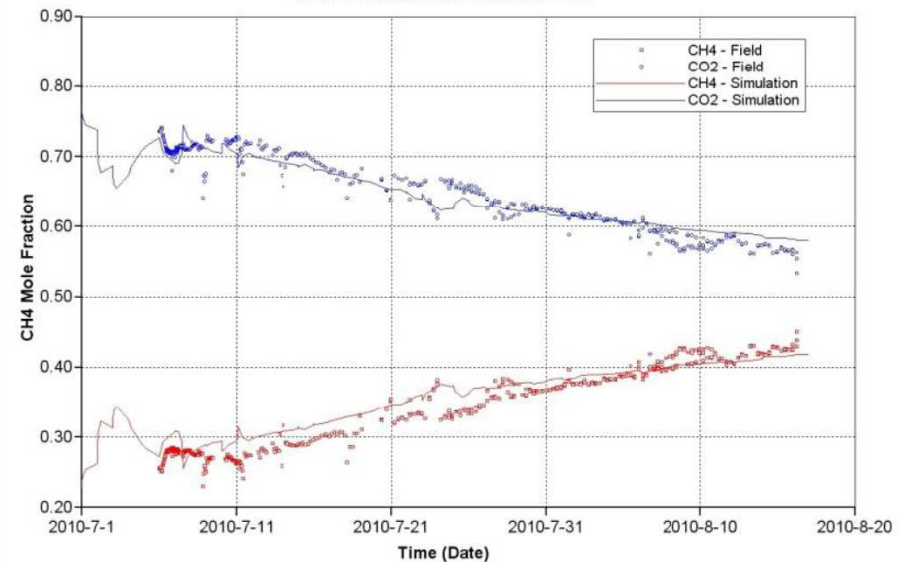
Bottom-hole Pressure



Gas Composition

Third Production Period

Mole Fraction of Produced Gas

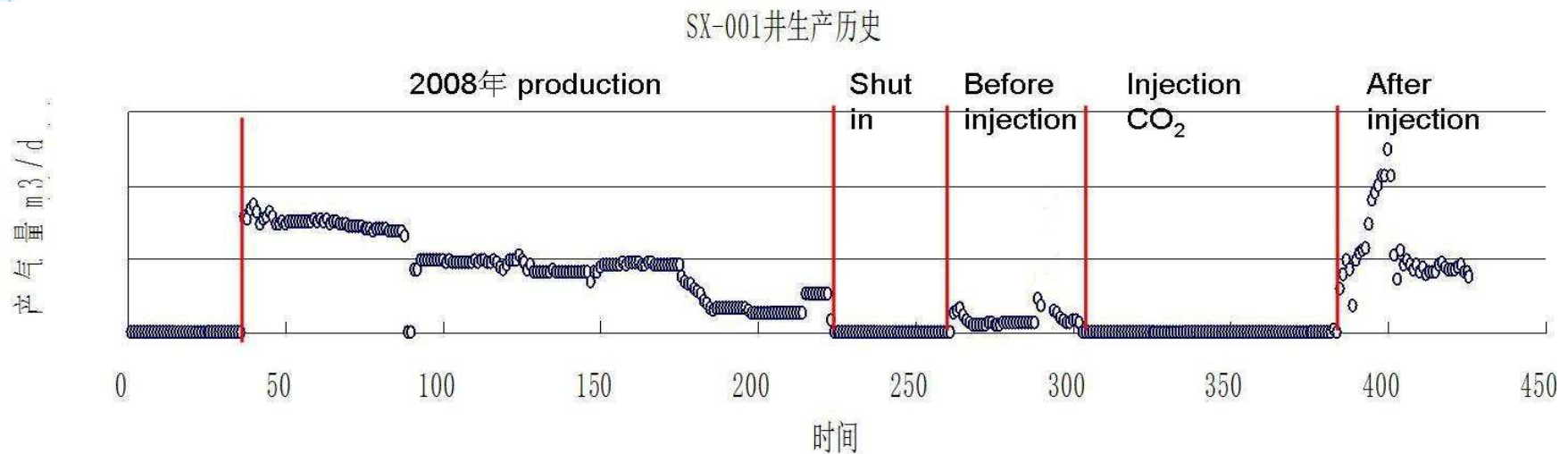


Micro-pilot test were successfully history matched



(2) 2007 , SX-001 field test

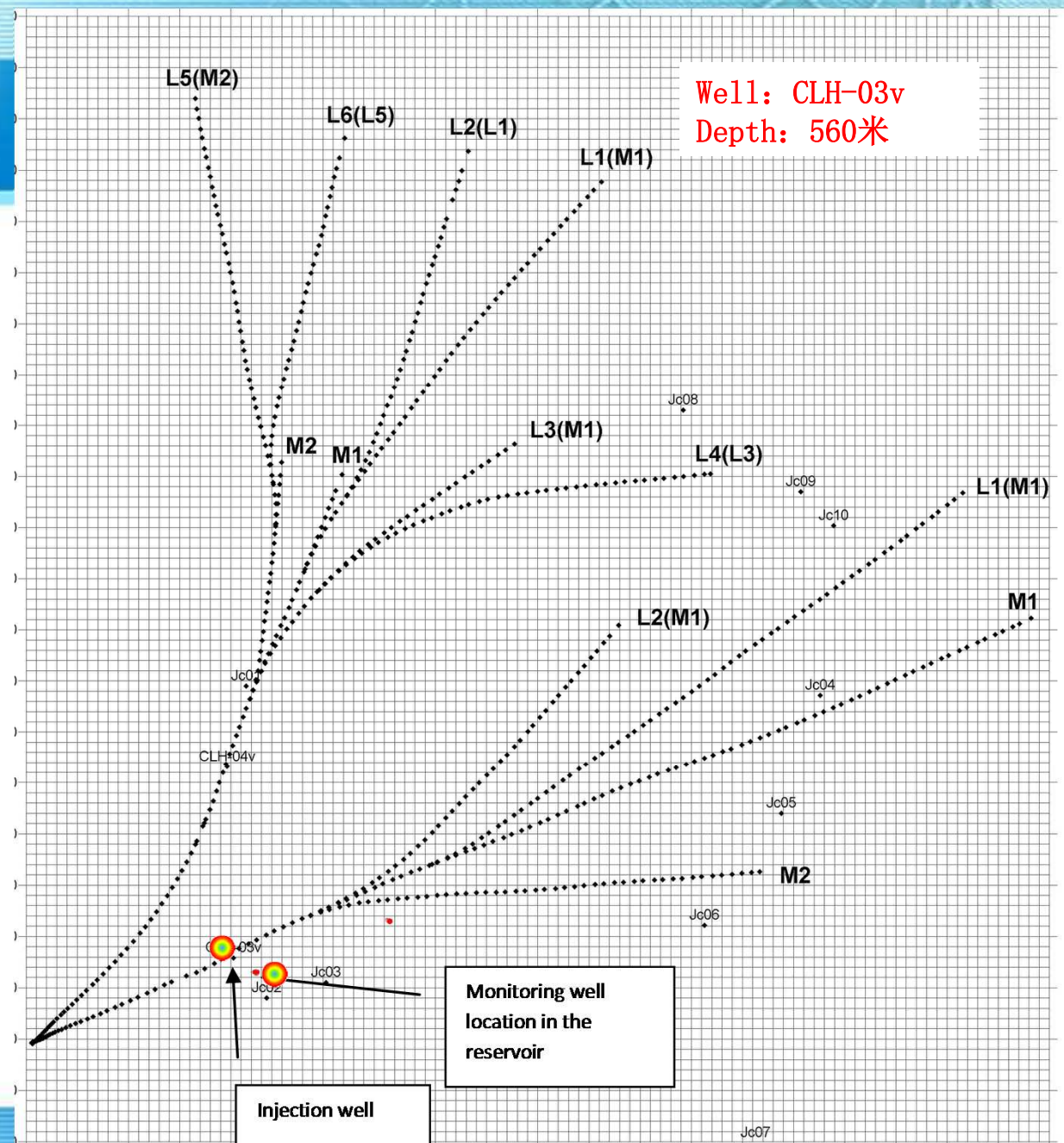
- Injected CO₂ 230 tons. Coalbed methane recovery simulation shows that the degree of increase 10 percent , forecast per square kilometer of carbon dioxide can be buried 300,000 m³.





(3) In 2010, horizontal wells injection project

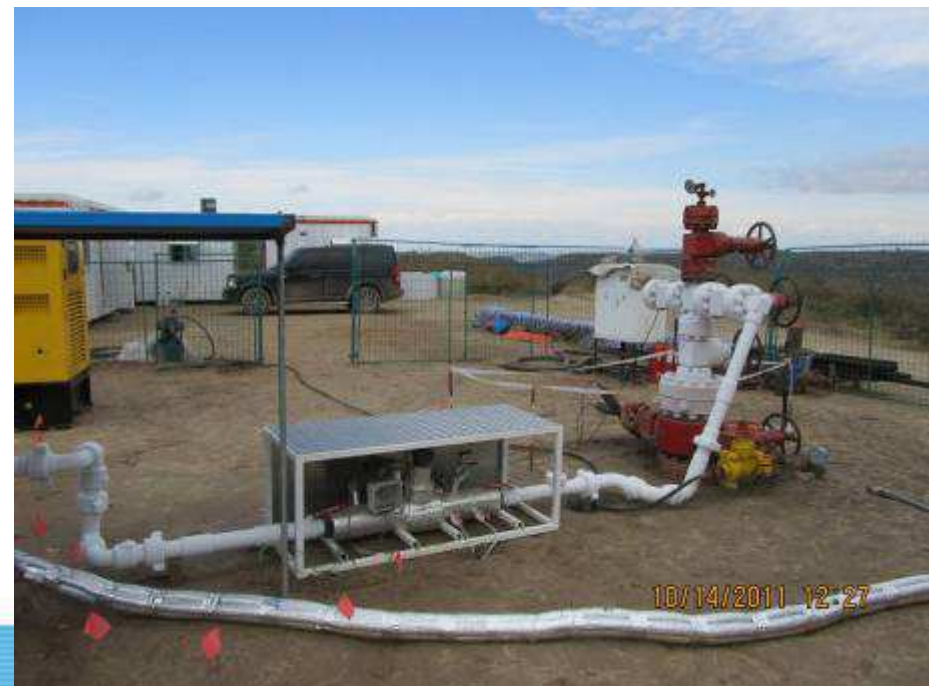






(3) In 2010, horizontal wells injection project

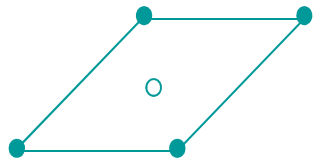
After the injection, production has increased from two thousand to five thousand m³.





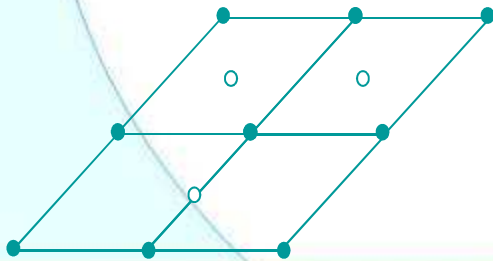
(4) 2011-2015 , "deep coal seam methane injected CO₂ displacement technology research and equipment development " (deep coal seams well group test)

2011-2012年



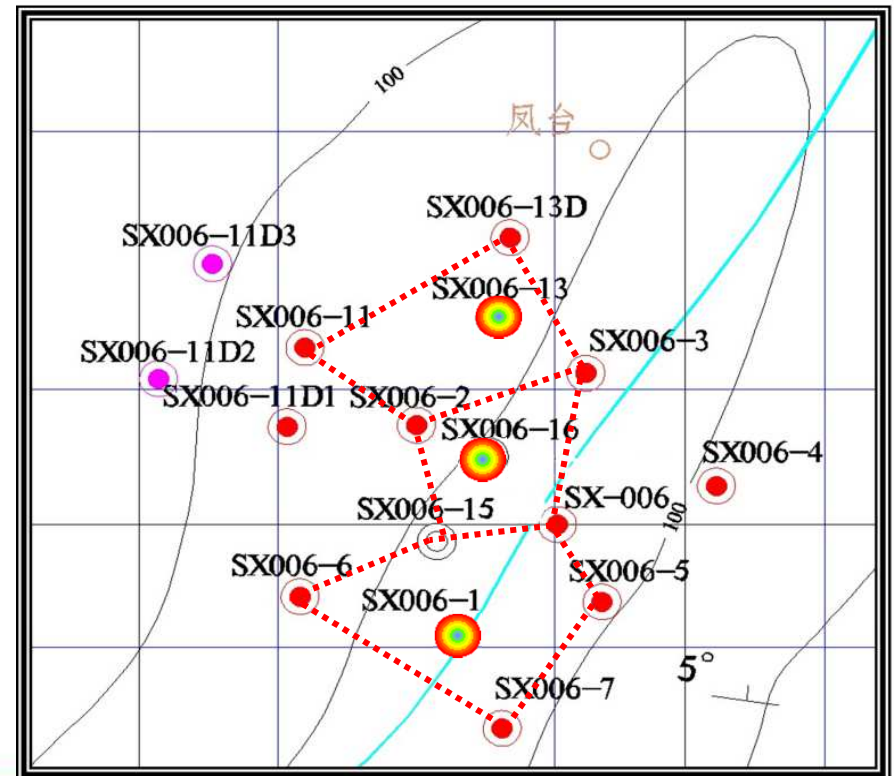
● Pro Well
○ Injec Well

2013-2015年



● Pro well
○ Injec Well

山西省柿庄北区块项目42课题三井组部署图





Summary

- ◆ Through systematic research on 3# coal seam in Qinshui Basin, it is believed that 3# coal seam in the area is suitable for the technical implementation of CO₂ injection for coal bed methane production.
 - Single well injected with carbon dioxide for coal bed methane production. Within the scope of carbon dioxide influence, the recovery degree can be improved to over 80%, and production increased over 2 times, indicating that the injection of carbon dioxide can effectively improve the recovery degree and production of coal bed methane.
 - Group well model was applied in simulation, and the recovery degree was improved by 10% after the analysis and injection of carbon dioxide.

谢谢！

