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CO_2 Sequestration potential in Coal Seams of China

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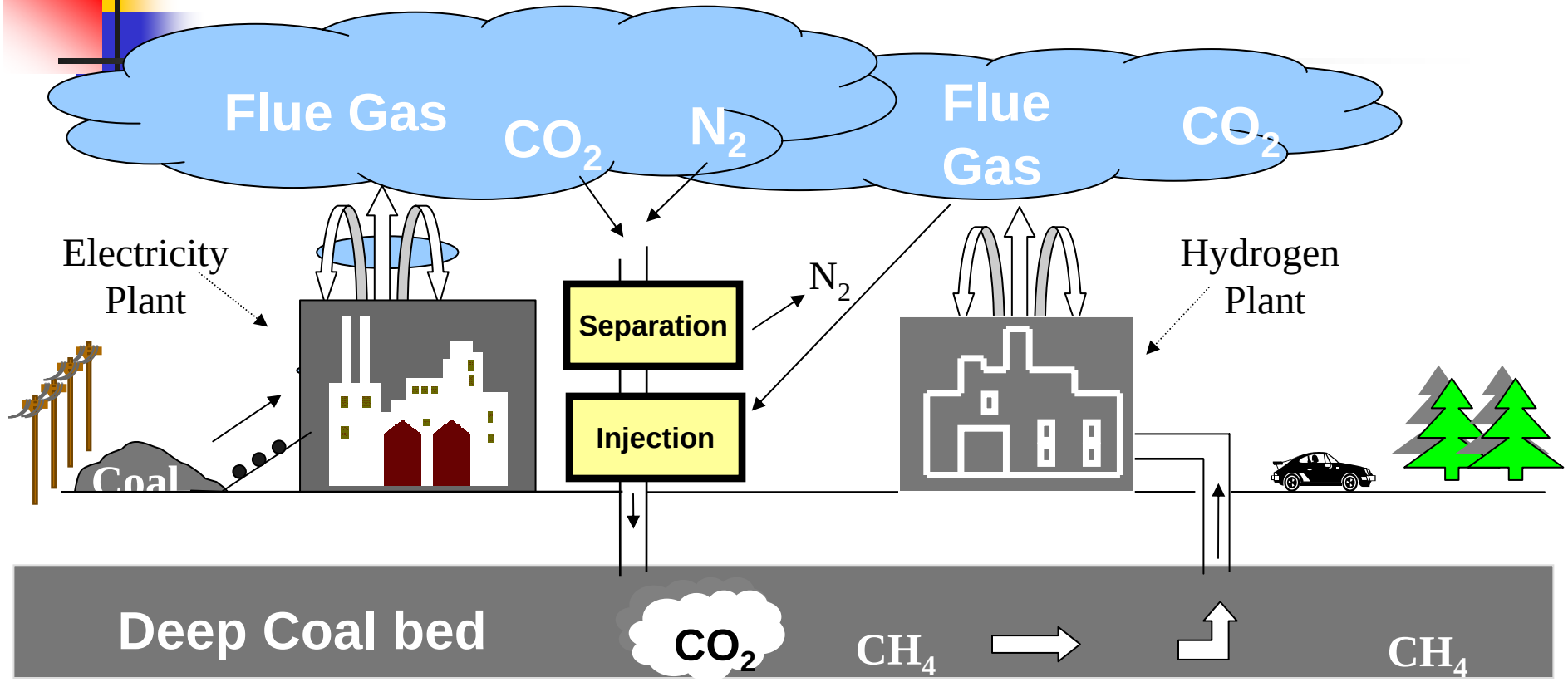
Outline of Presentation

- The enhanced coalbed methane (ECBM) and CO_2 Sequestration process
- Laboratory measurements of CO_2 / CH_4 adsorption
- Micro-pilot field test in south Qinshui basin
- CO_2 storage potential in coal seams in China

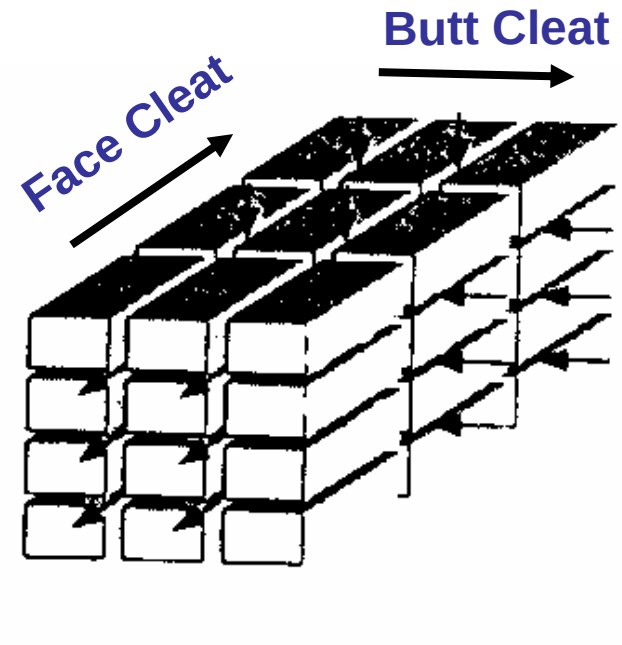
1 The enhanced coalbed methane (ECBM) and CO_2 Sequestration process

Opportunity to address both Gas Supply and Environment

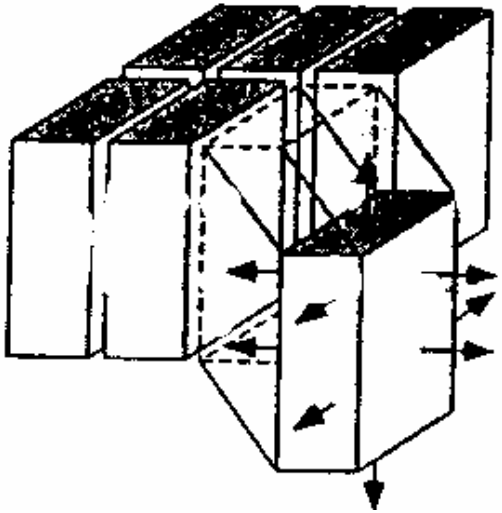


- Enhanced coalbed methane (ECBM) recovery
- Sequestration of CO_2

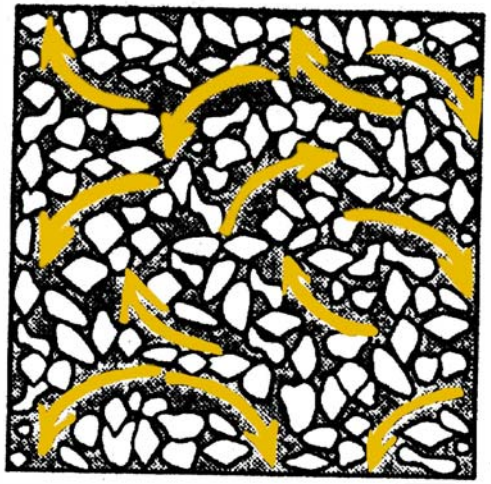
Process of Gas Transport in Coalbed Methane Reservoirs



1. Fluid Production from Natural Fractures

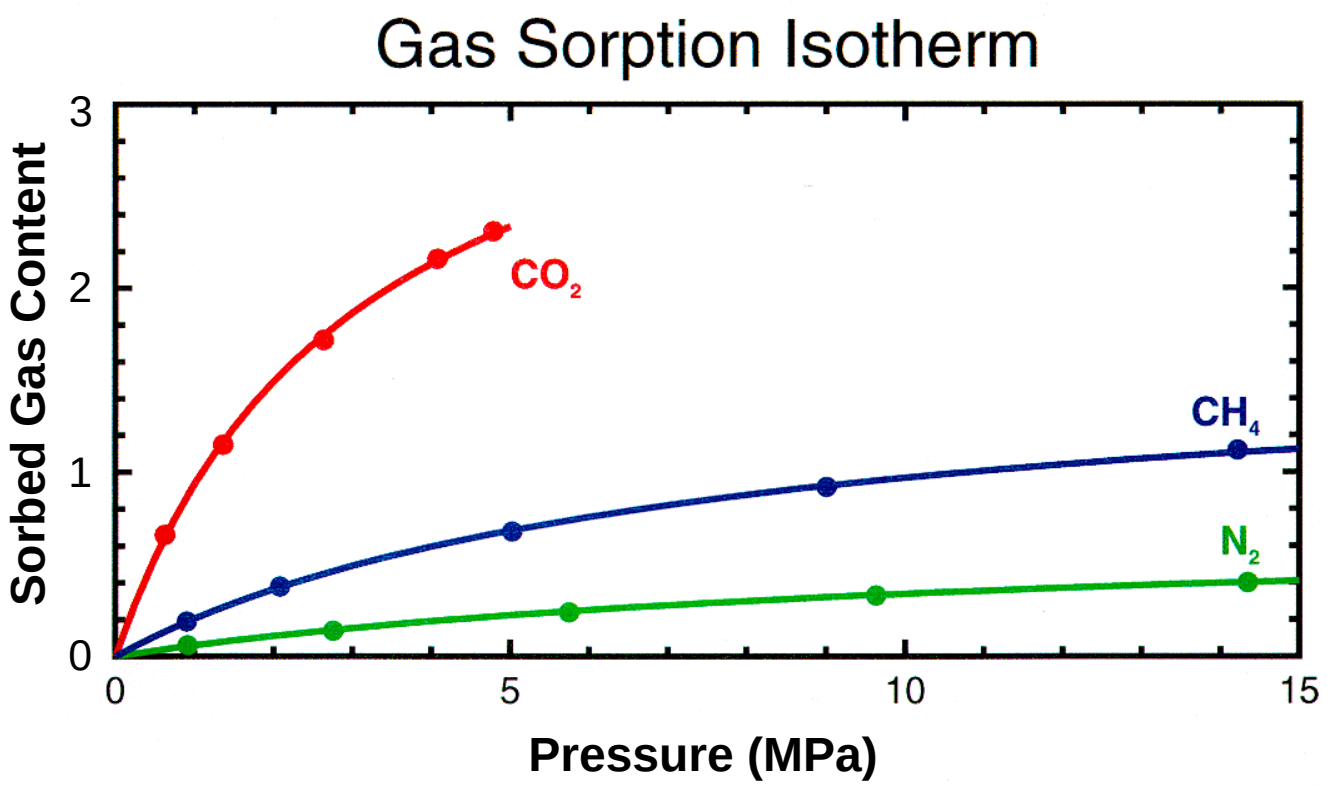


2. Gas Desorption from Cleat surfaces

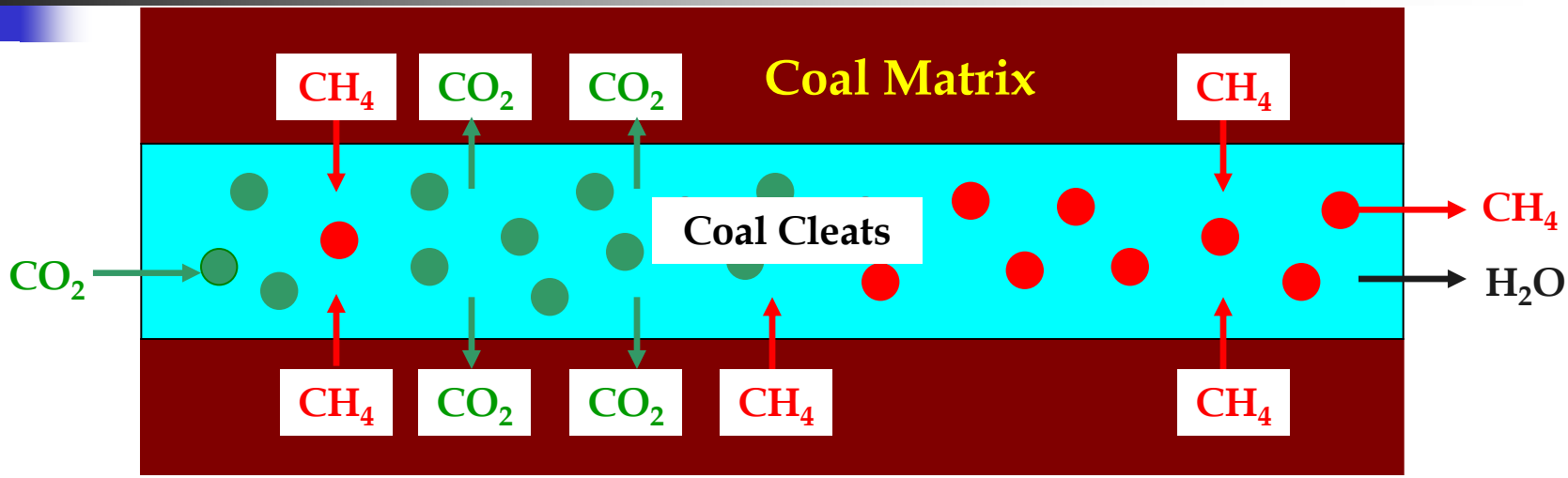


3. Molecular Diffusion through the coal matrix

Sorption Data for Different Pure Gases

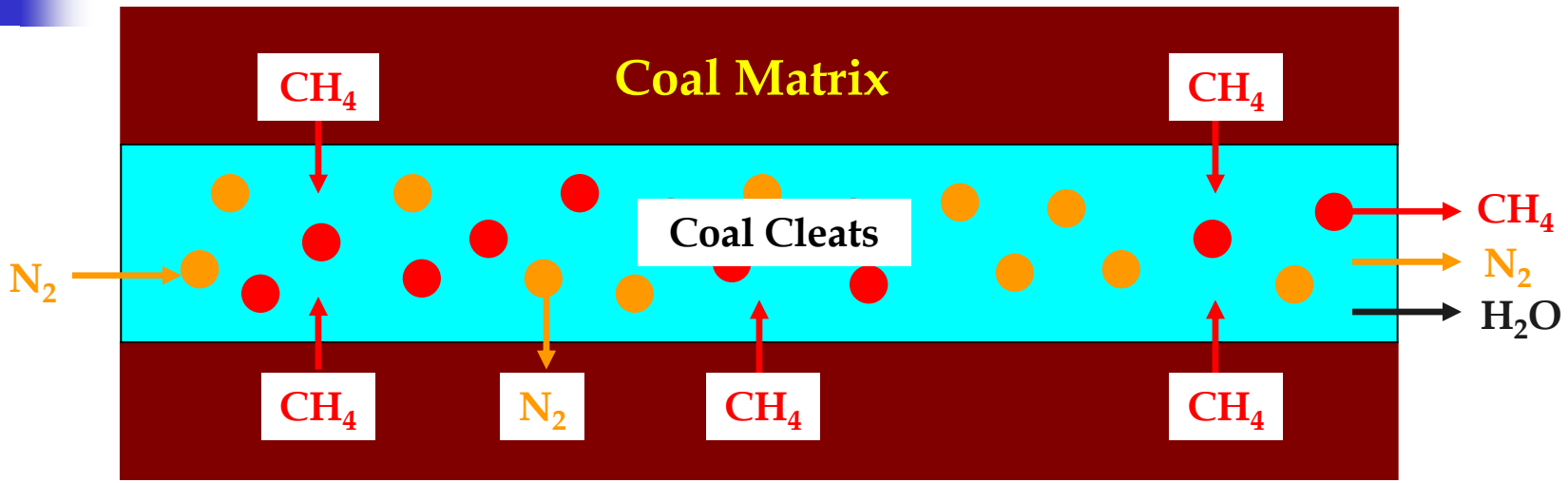


CO_2-ECBM Recovery Mechanisms



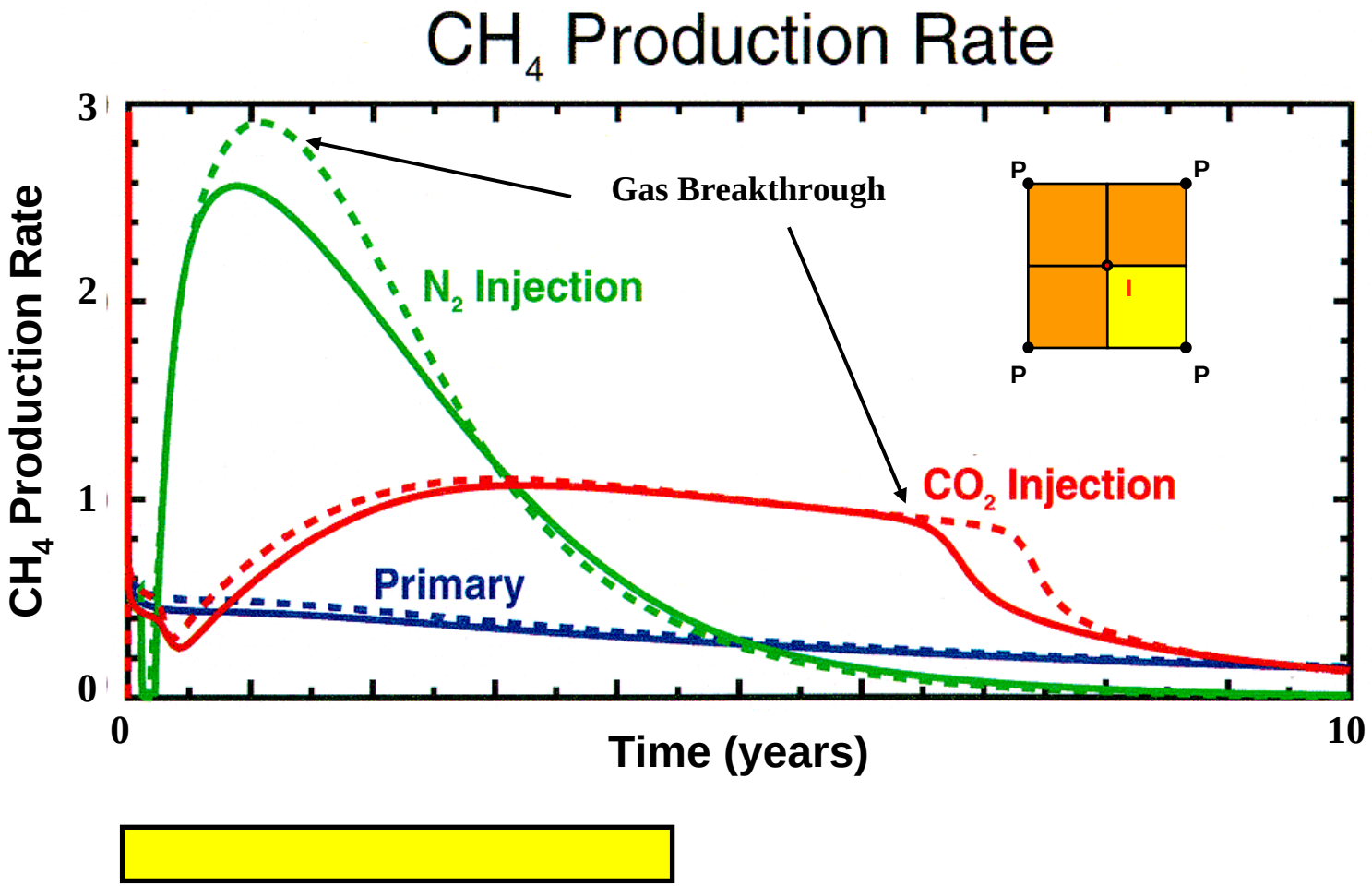
- Injected carbon dioxide in cleats
- Increases total cleat pressure
- Carbon dioxide diffuses into matrix and strongly adsorbs onto coal
- Reduces partial pressure of methane in cleats
- Methane desorbs from matrix and diffuses to cleats
- Methane and water flow to wellbore

N_2-ECBM Recovery Mechanisms



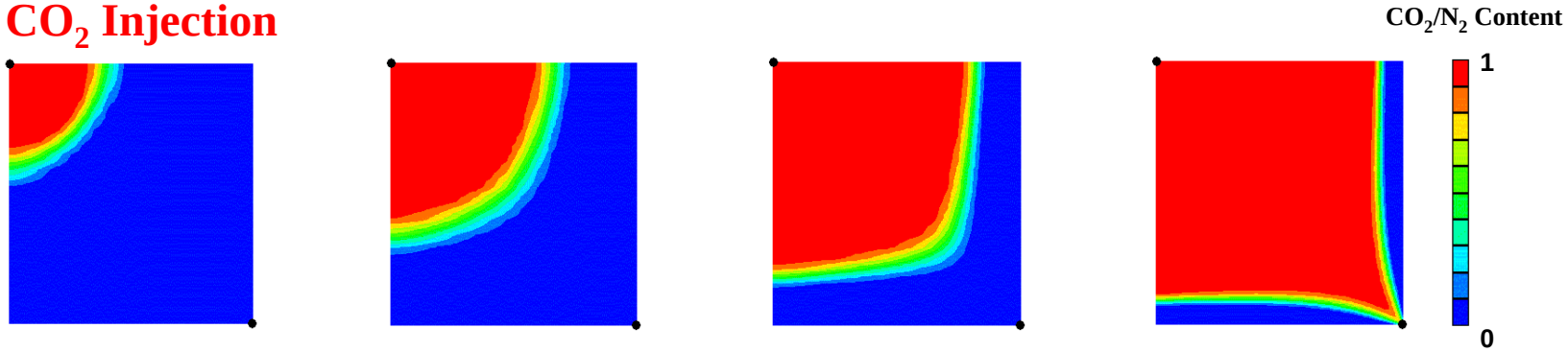
- Injected nitrogen into cleats
- Increases total cleat pressure
- Nitrogen diffuses into matrix and weakly adsorbs onto coal
- Reduces partial pressure of methane in cleats
- Methane desorbs from matrix and diffuses to cleats
- Methane, nitrogen and water flow to wellbore

ECBM Production Profile

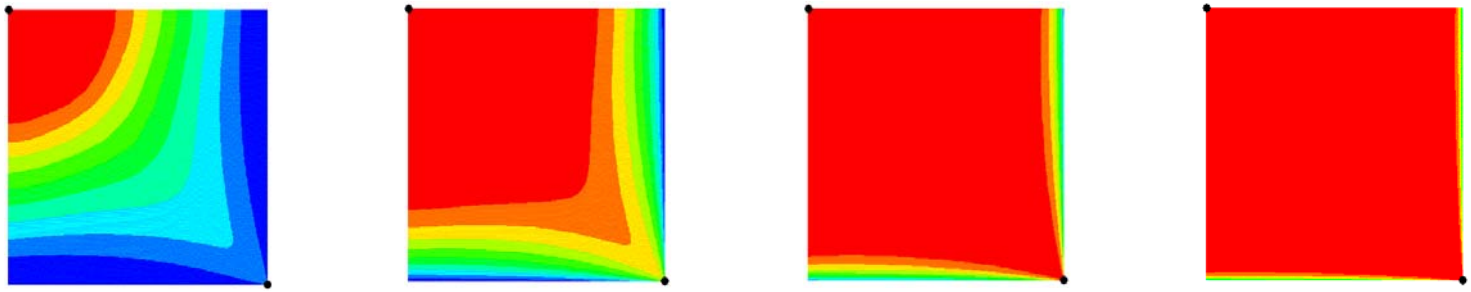


5-Spot Pattern Simulation
CO_2 and N_2 Propagation

CO_2 Injection



N_2 Injection



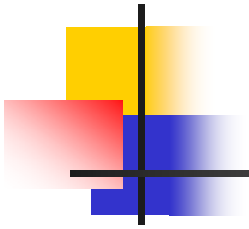
After 1 year | After 3 years | After 5 years | After 7 years

1/4 of 5-Spot Pattern

Constant Injection Rate

ECBM Process

- CO_2 is stored in the coal and will not breakthrough to the producing wells until most of the coalbed methane is produced
- N_2, because it is less adsorbing, will be produced with the coalbed methane and breakthrough to the producing wells quickly



2 Laboratory Measurements of CO_2 and CH_4 Adsorption

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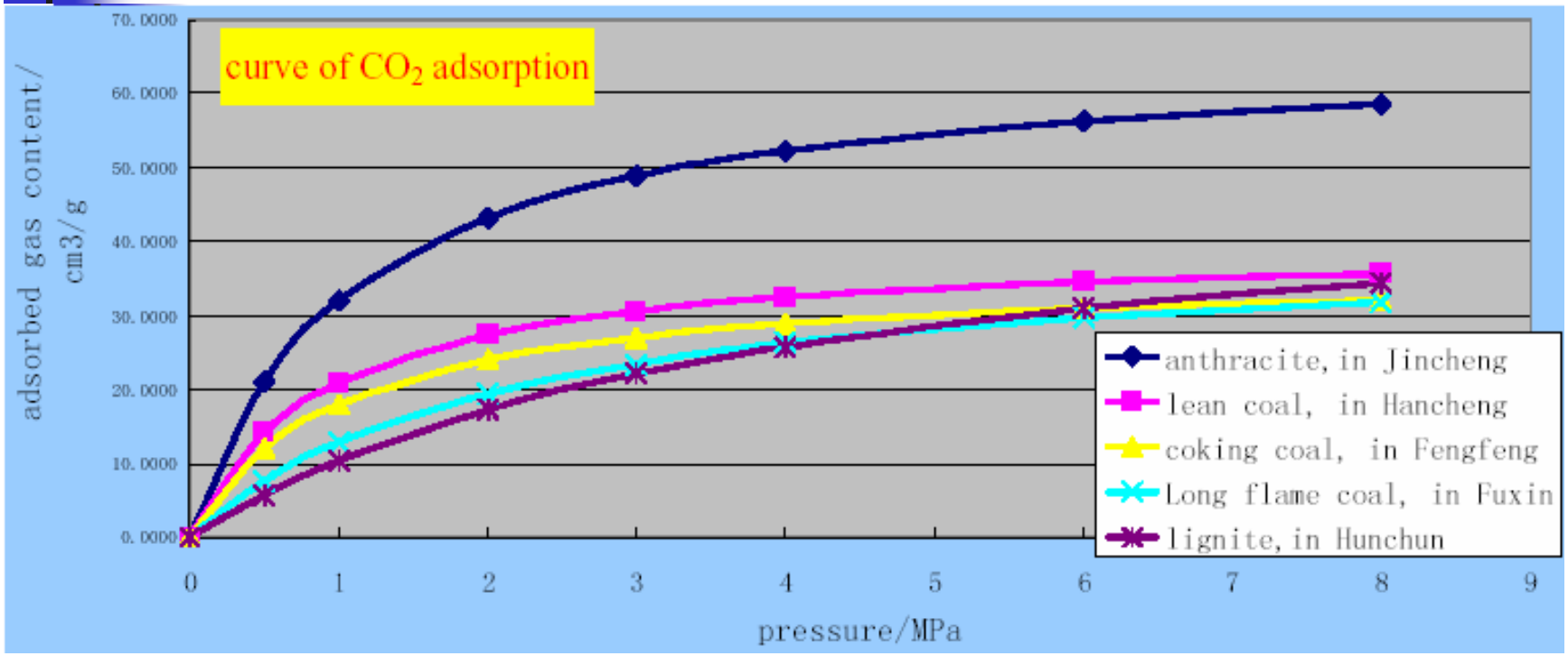
Experiment of CH_4 and CO_2 adsorption/desorption in five coal samples with different rank :

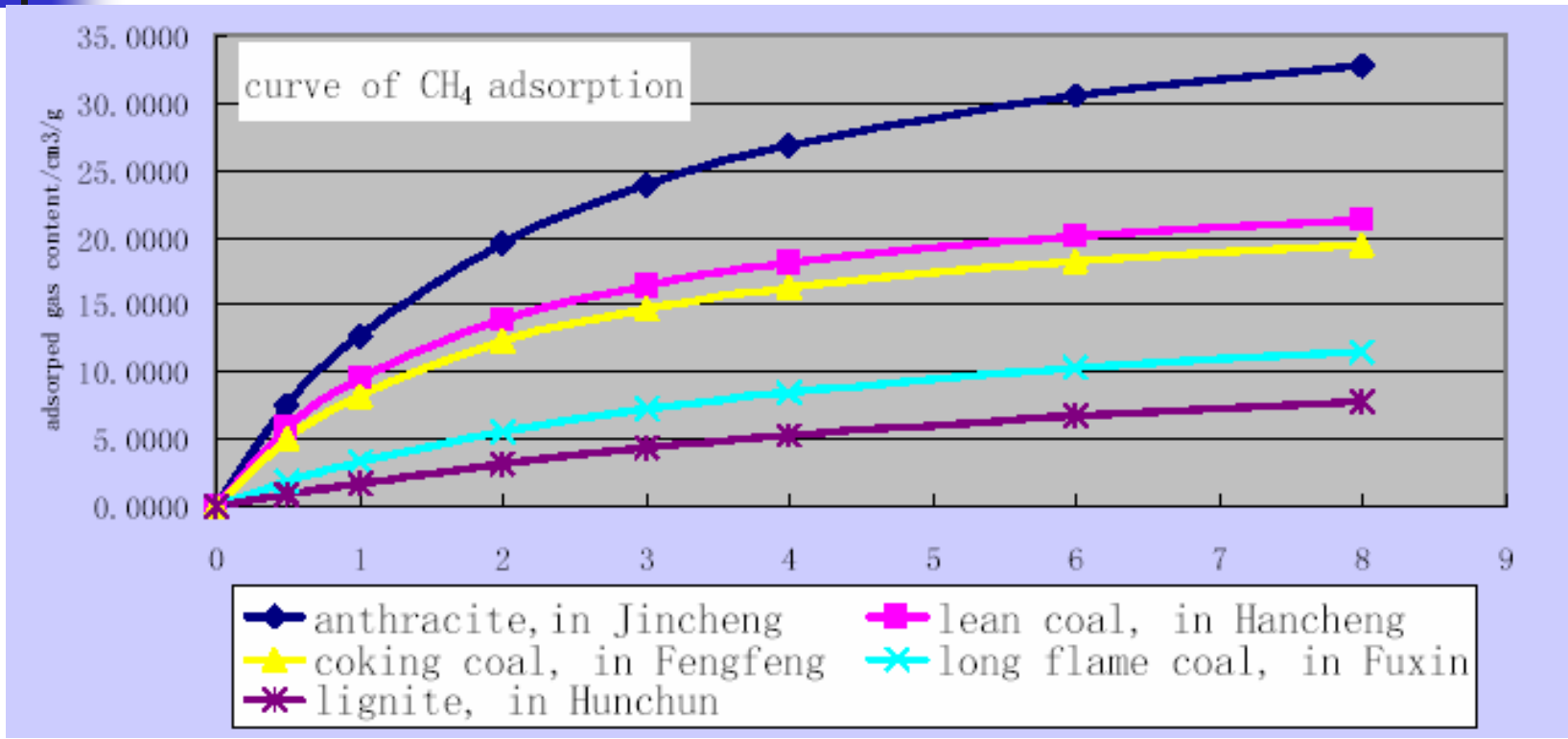
- **Anthracite (coal sample Ro 3.62%)**
- **Lean coal (Ro 1.94%)**
- **Coking coal (Ro 1.52%)**
- **Long flame coal (Ro 0.56%)**
- **lignite (Ro 0.49%)**

2 Laboratory Measurements of CO_2 and CH_4 Adsorption



CO_2 adsorption capacity increases when coal rank increases.

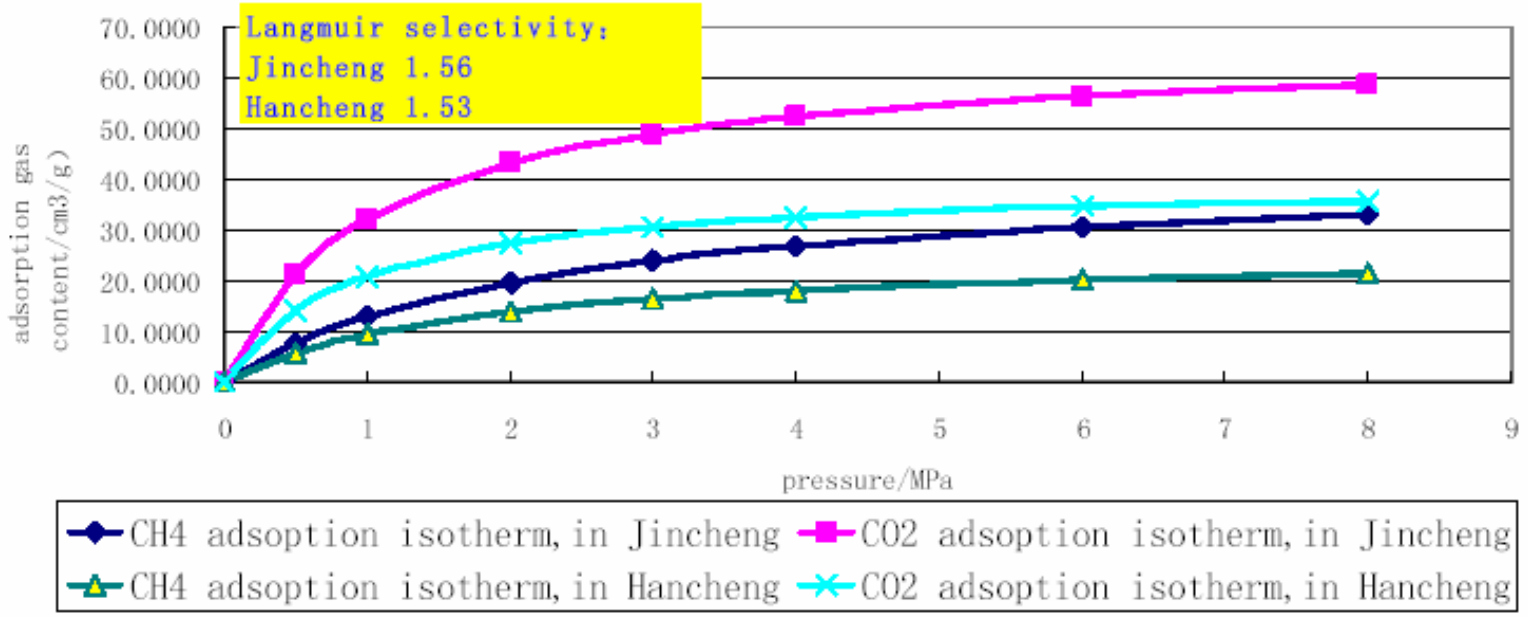
2 Laboratory Measurements of CO_2 and CH_4 Adsorption



CH_4 adsorption capacity increases when coal rank increases.

2 Laboratory Measurements of CO_2 and CH_4 Adsorption

- CO_2 Adsorption capacity is greater than CH_4.
- CO_2 Adsorption selectivity decreases relative to methane ,when coal rank increases. Langmuir selectivity for CO_2 to $CH_4$are from 3.3:1 to 1.5:1 from lignite to anthracite.



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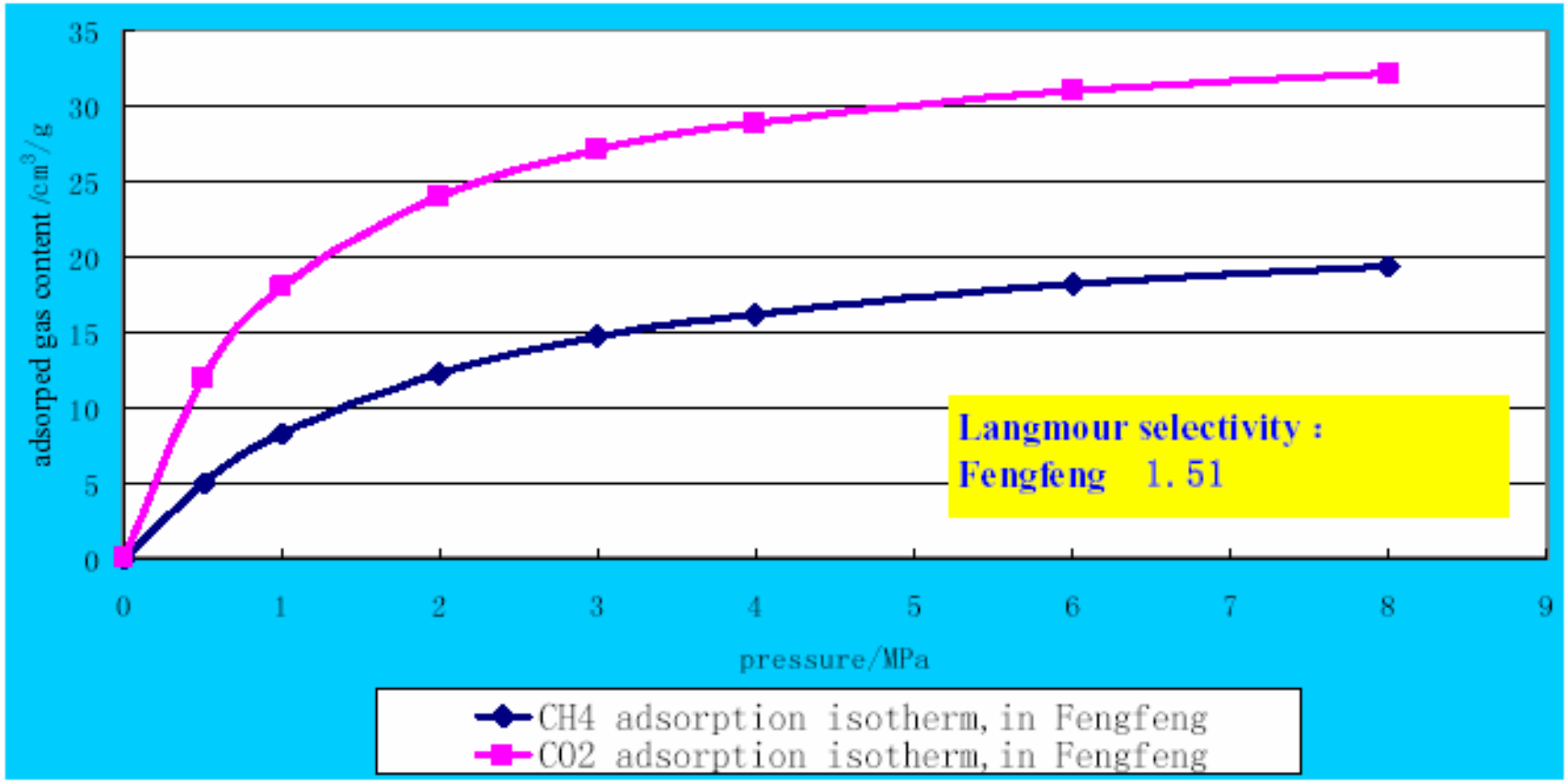

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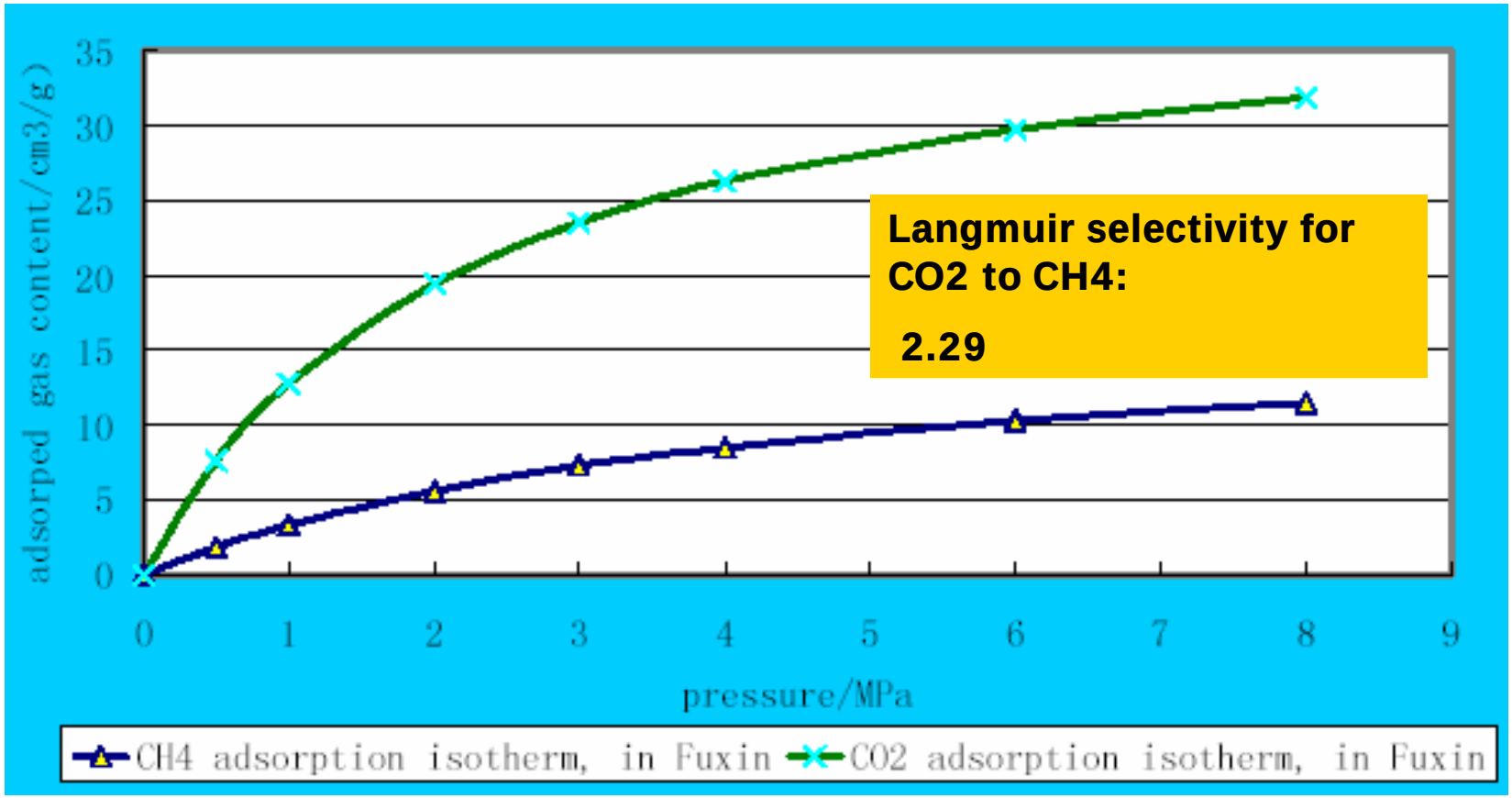

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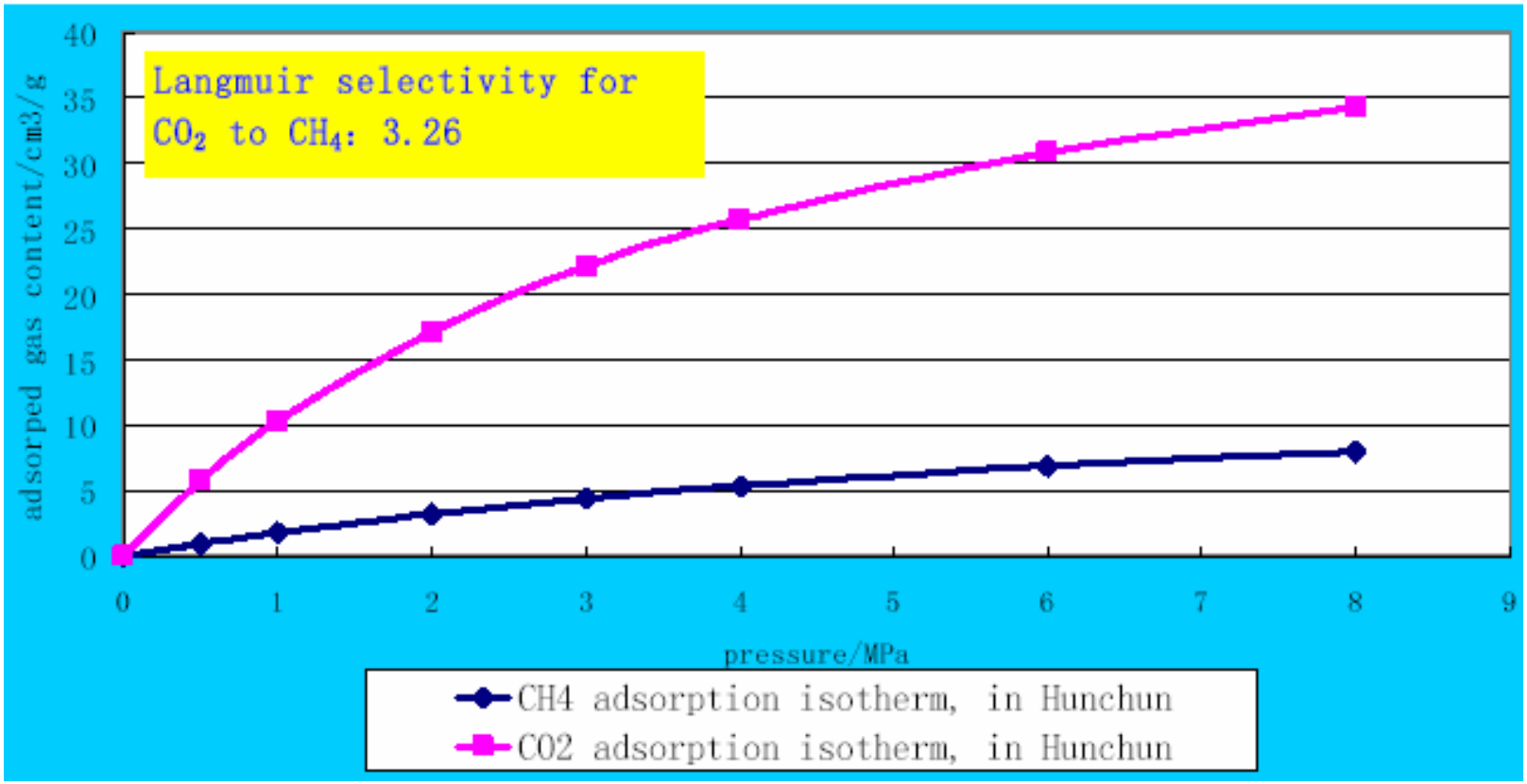


2 Laboratory Measurements of CO_2 and CH_4 Adsorption

Experiment results:

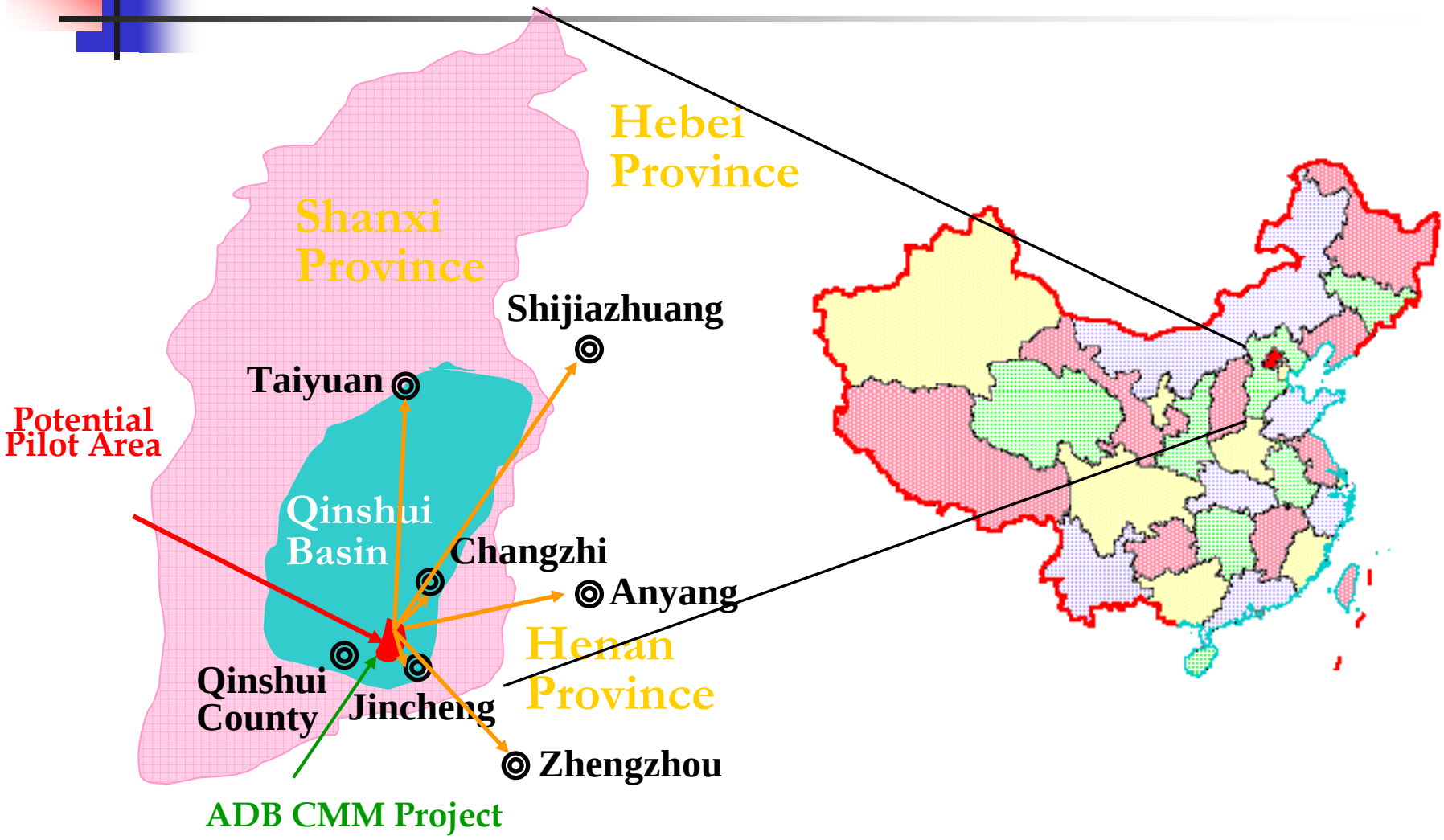
CO_2 and CH_4 adsorption capacity also increases when coal rank increases。 But Langmuir selectivity for CO_2 to CH_4 decreases when coal rank increases. Langmuir selectivity for CO_2 and CH_4 is greater in the lignite than in the anthracite.

3 Micro-pilot field test in south Qinshui basin

China United Coalbed Methane Co.,Ltd (CUCBM)

- **State-owned company under the direct auspices of the State Council, including the State Plan, Finance, Science and Technology**
- **Exclusive rights for exploration, development and production of CBM in cooperation with foreign companies**
- **Professional company responsible for exploration, development, production and sale of CBM in China**

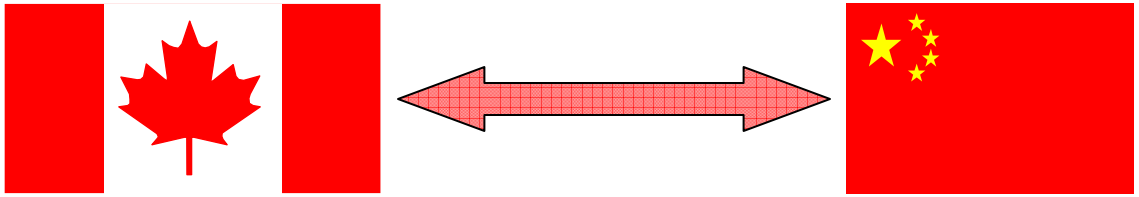
Demonstration Site Location



Activities in South Qinshui Basin

- **170 wells and more than 660 2-D seismic lines have been completed by CUCBM. (Up to Aug. 18, 2005)**
- **3 CBM pilots have been set up.**
- **1 National test field for CBM development has been confirmed.**
- **1 Z-pinnate System has been tested.**
- **1 CO_2 micro-pilot**

China ECBM Project



Canadian International Development Agency (CIDA)

Ministry of Commerce (MOFCOM)

Canadian Climate Change Development Fund (CCCDF) (CA $ 5 million)

China United Coalbed Methane Corporation Ltd. (CUCBM) (CA $ 5 million)

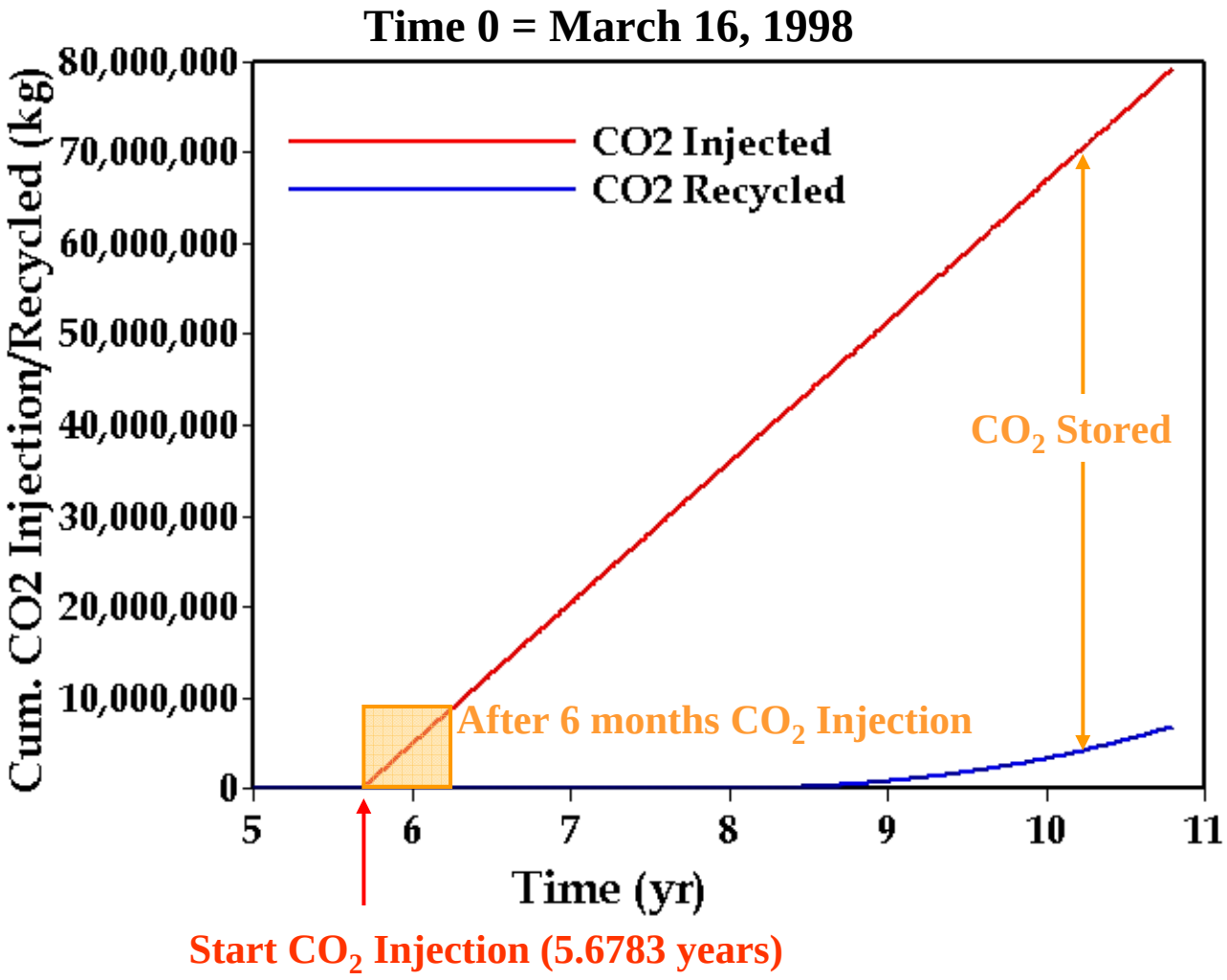
3.5 - year CA $ 10 million Project (Started March 2002)

First Micro-Pilot Test
Qinshui Basin

- **The first micro-pilot test was successful**
- **CMG's GEM CBM Model has been validated based on successful history match of the micro-pilot field data**
- **Prediction of the performance of CO_2-ECBM recovery process indicated that more than 4 times the average CH_4 production rate compared to primary recovery can be achieved**
- **CO_2 storage into high-rank anthracite coal seam in Qinshui Basin is feasible**
- **Start design of multi-well pilot on site**

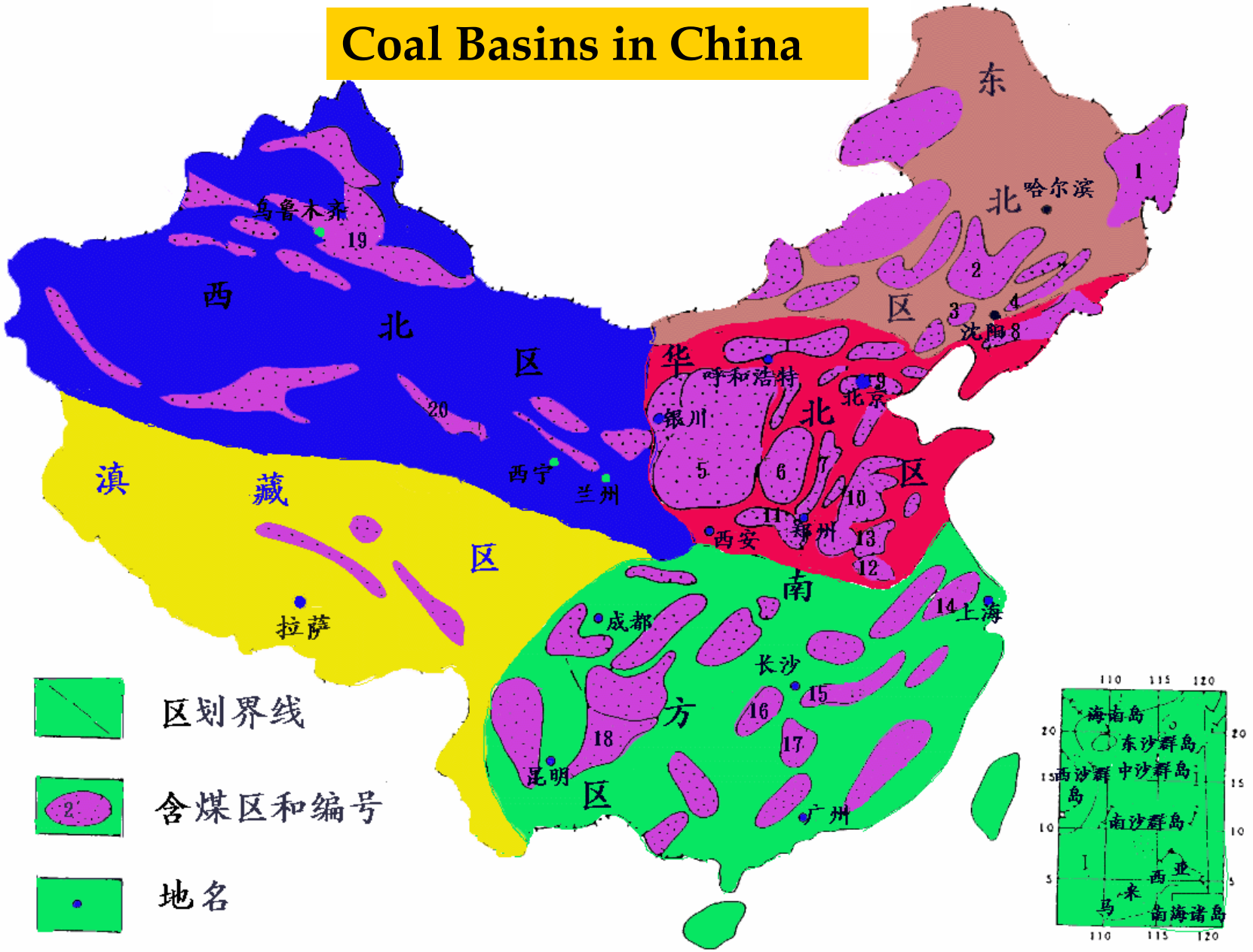
5-Spot Field Pilot Test Prediction

CO_2 Inventory



4. CO_2 storage potential in coal seams in China

Coal Basins in China

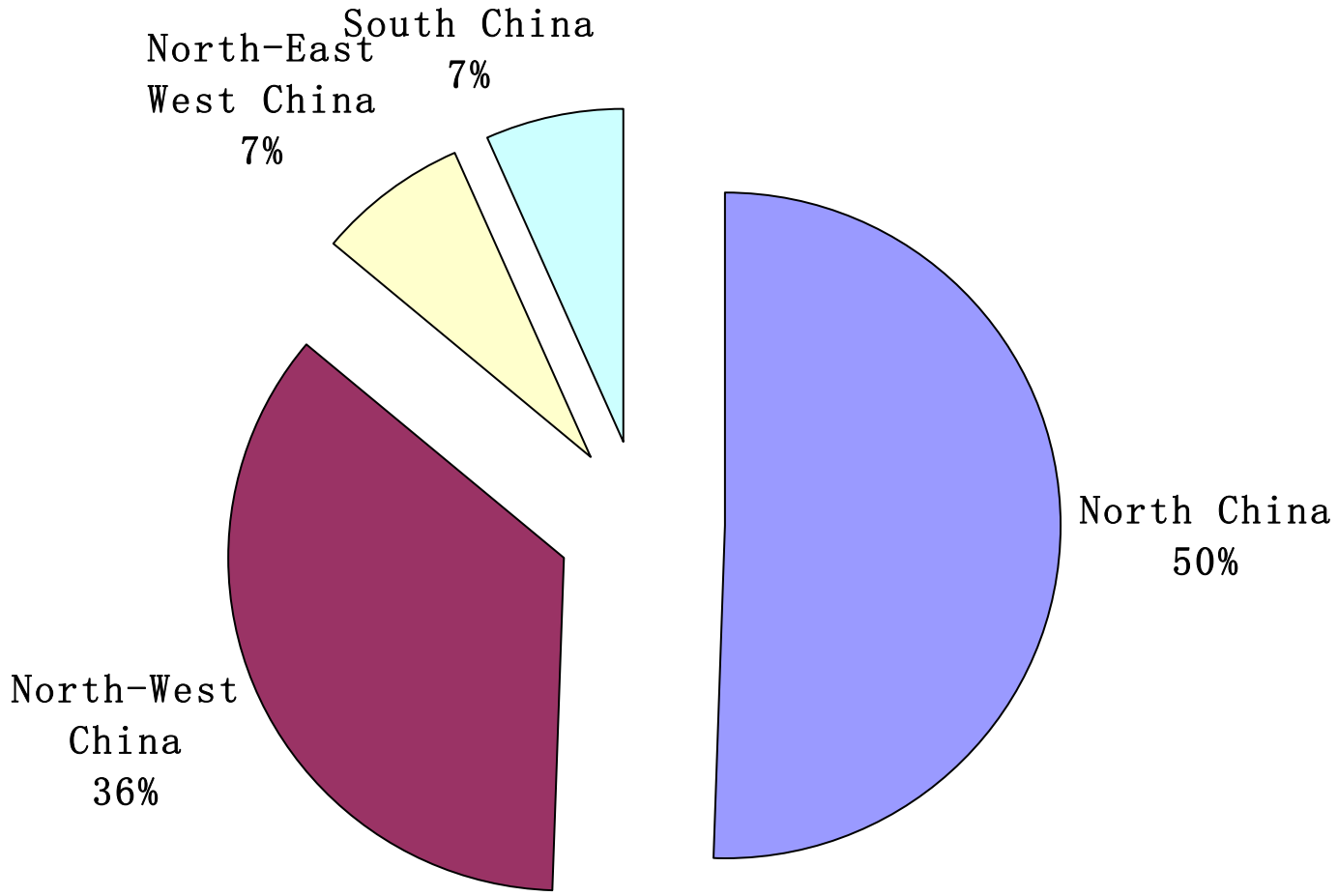


4. CO_2 storage potential in coal seams in China

- coal resource is 5.57×10^{12}t over 2000m depth in China
- coal resource is 2.71×10^{12}t between 1000-2000m depth in China

Data from China administration of coal geology, 2000

4. CO_2 storage potential in coal seams in China



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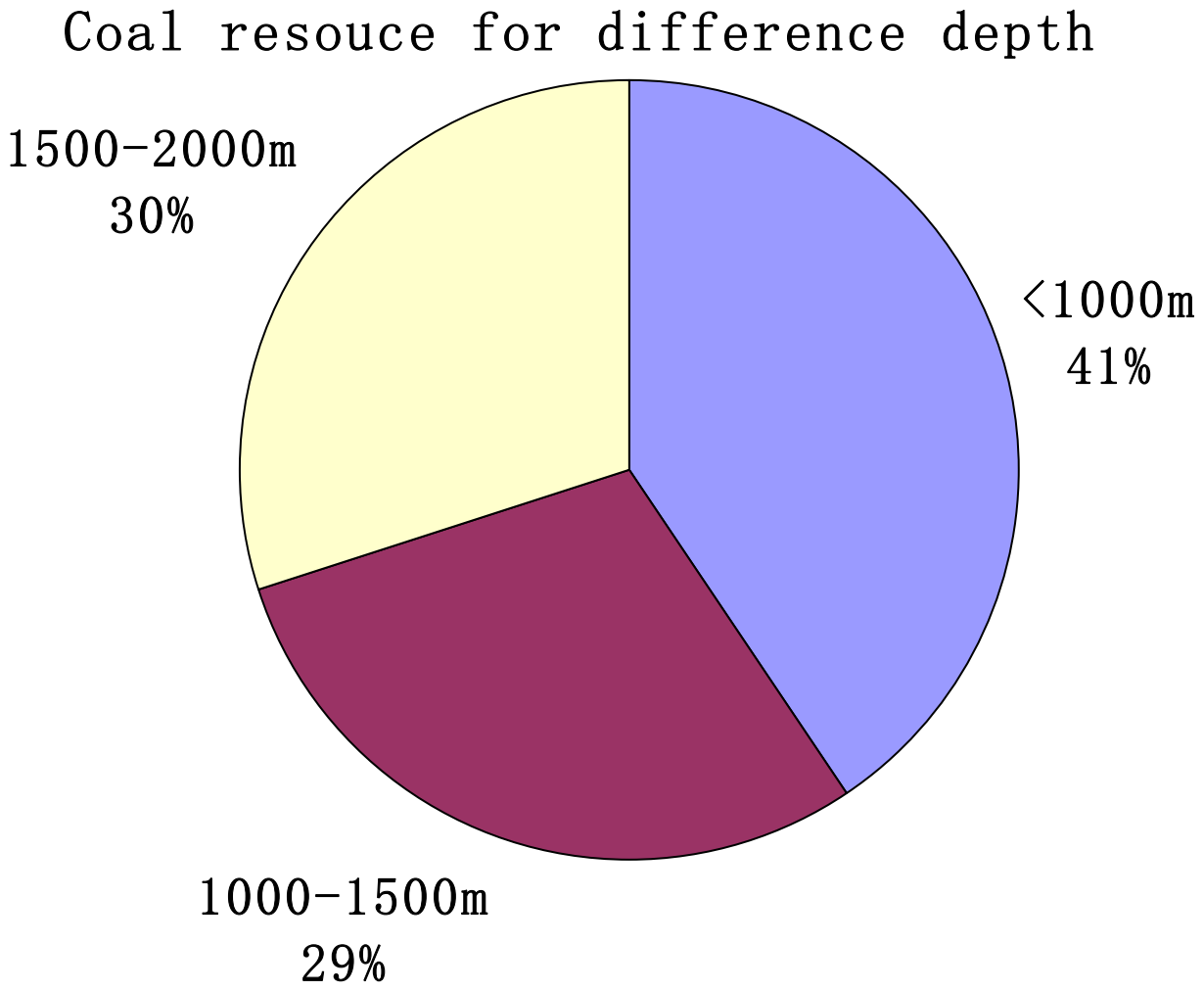

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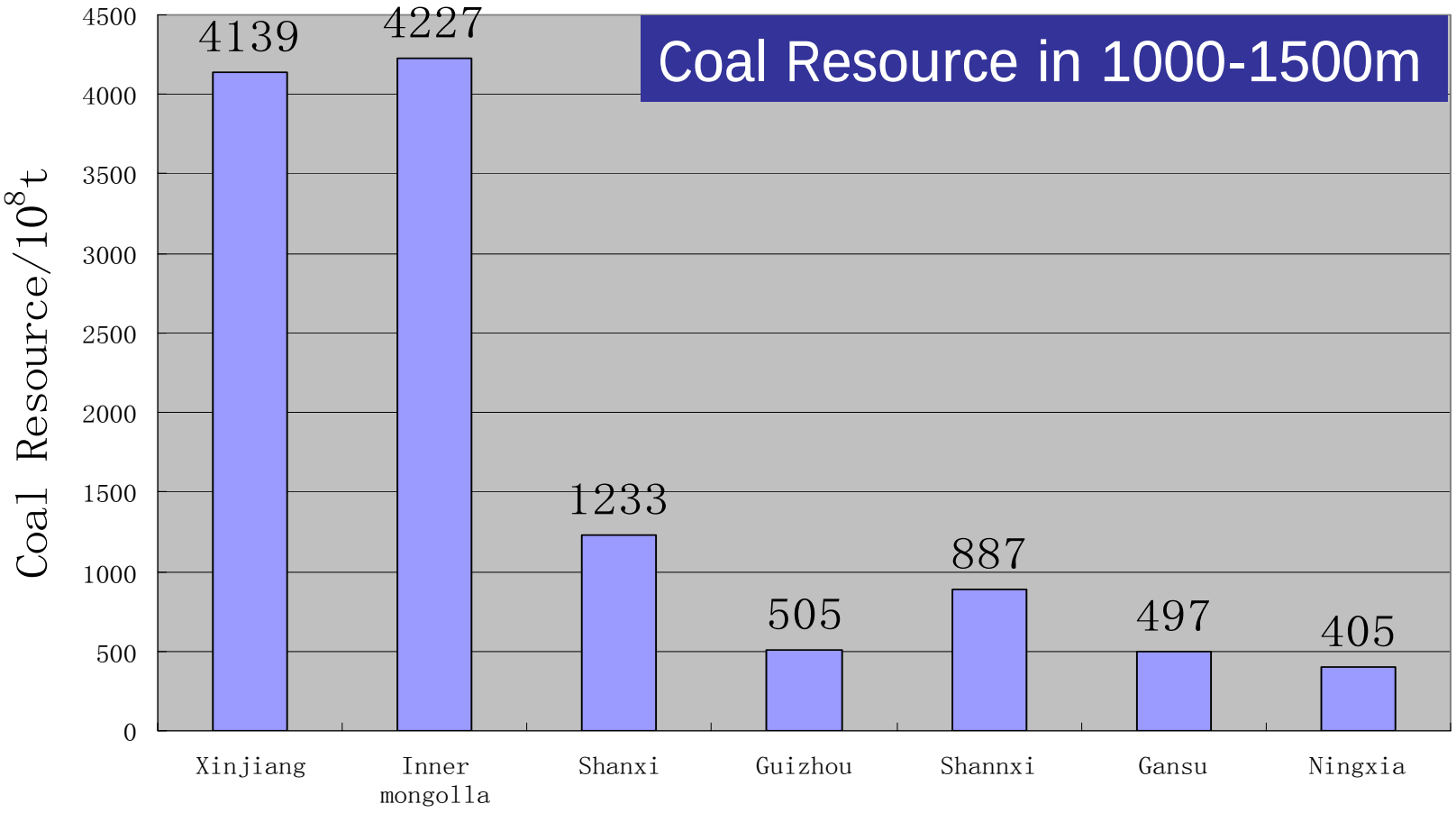

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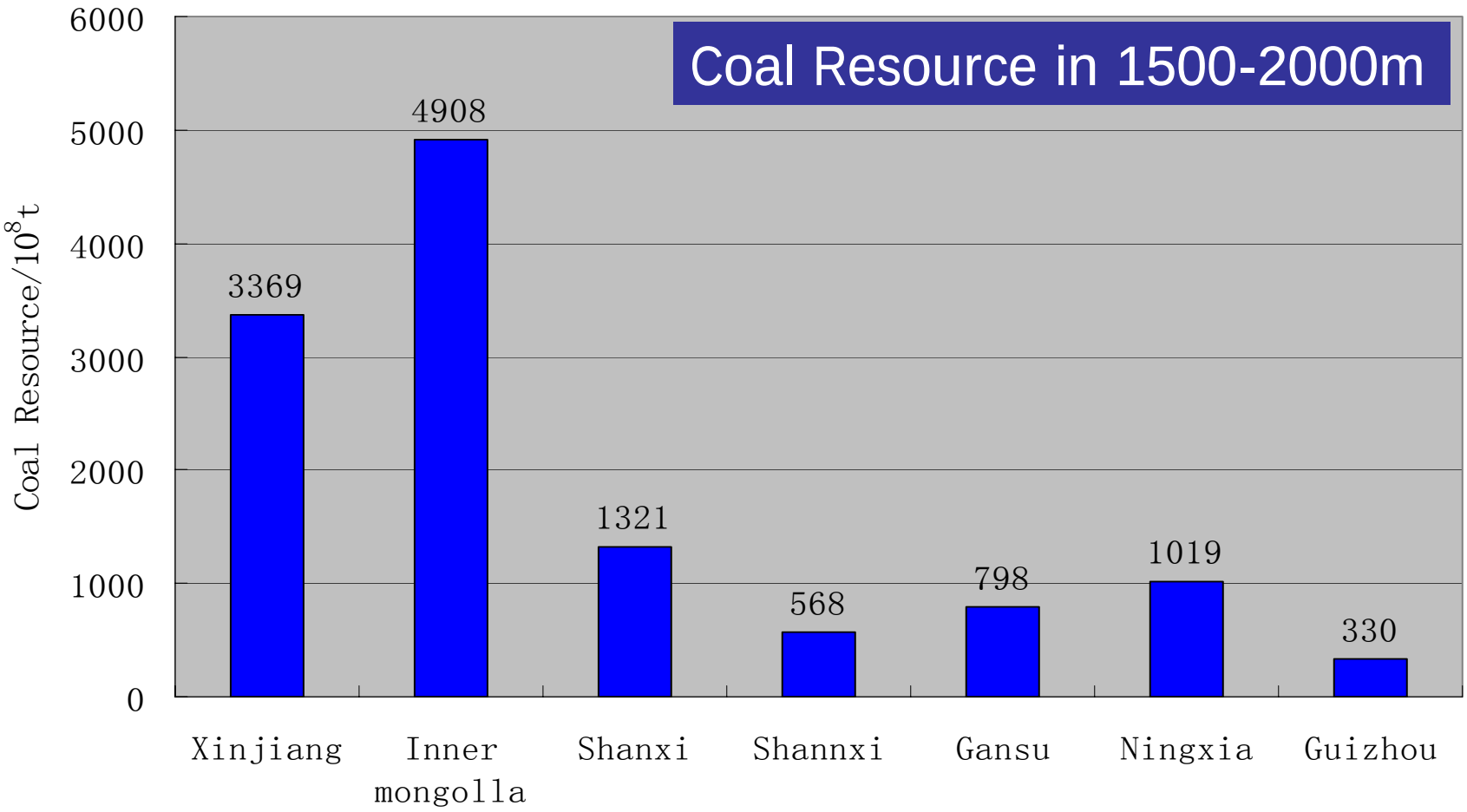

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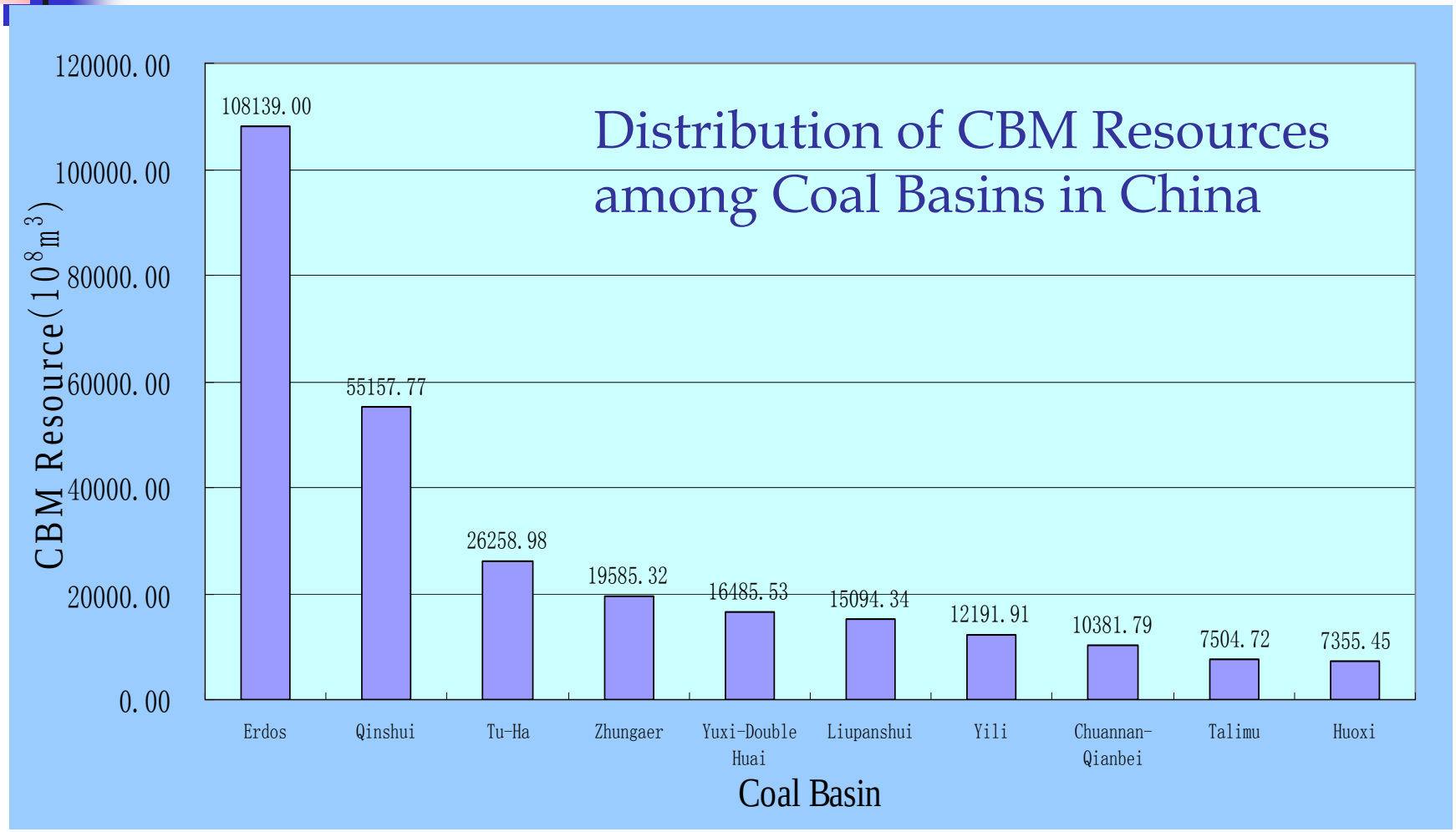

Summary

- Coal resource is rich in China, Total Coal resource is 5.57×10^{12}t. coal resource is 2.71×10^{12}t between 1000-2000m depth. Coal mainly distributes in North China and North-west China.
- That injecting CO_2 to coal seams not only enhance coalbed methane recovery, but also storage CO_2 .
- CO_2 storage potential on coal is great in China.

THANK YOU